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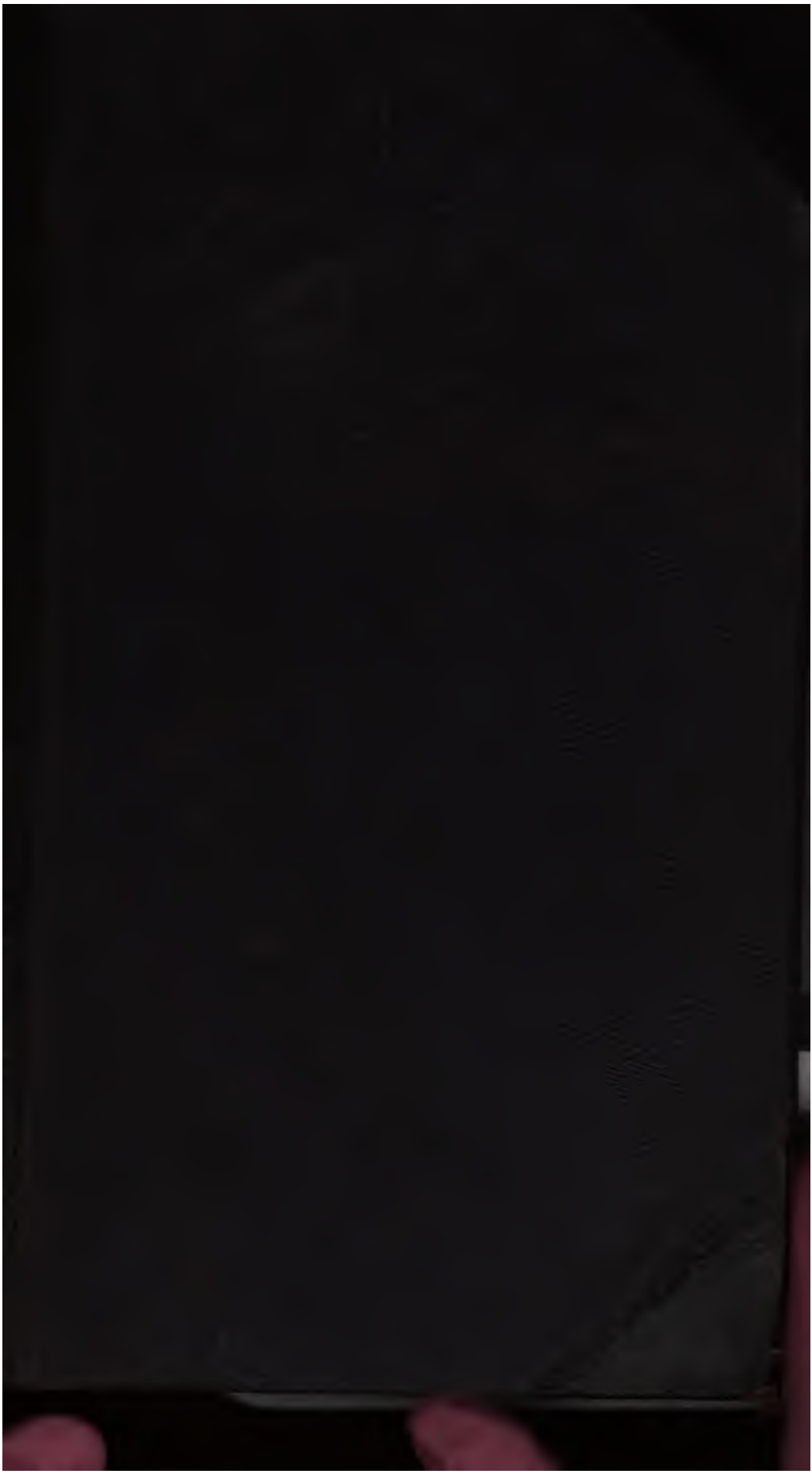

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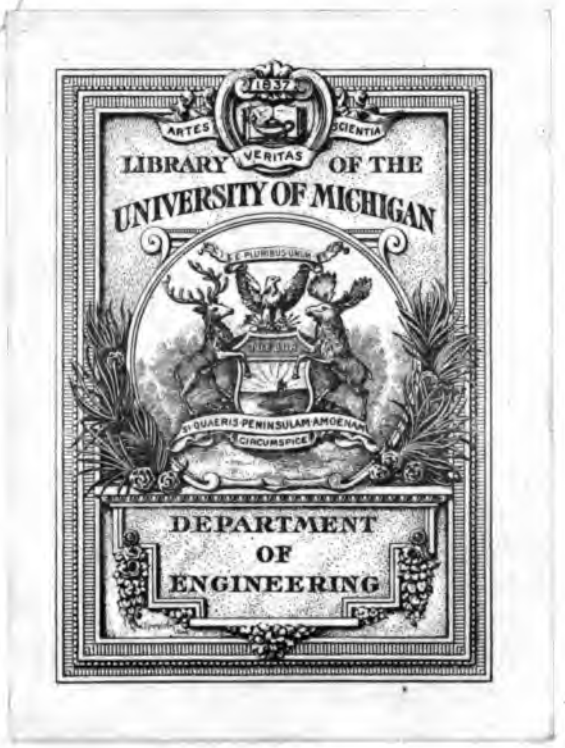
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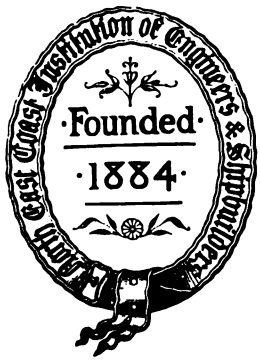

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VOLUME XX.

TWENTIETH SESSION, 1903-1904.

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Armstrong, Joseph, 50, High Southwick, Sunderland ... ... (S) Nov. 1892
Armstrong, Robert B., c/o Messrs. Day, Summers & Co., Northam Ironworks, Southampton ... ... (E) Oct. 1887
Armstrong, Walter, 14, Elwin Terrace, Sunderland... ... ... (S) May 1899
Ascroft, Frederick W., 11 Park Street, Lytham ... ... (E) May 1900
Atherton, William Henry, M.Sc., 2, Holly Lea, Lime Avenue, Urmston, Manchester ... ... (E) Oct. 1891
Atkinson, Alfred, c/o Messrs. Clark, Chapman & Co., Victoria Works, Gateshead-on-Tyne ... ... (E) May 1901
Atkinson, F. C., 37, Croydon Road, Newcastle-upon-Tyne... ... (E) Dec. 1892
Atkinson, George H., 3, Acclom Street, Hartlepool ... ... (E) Nov. 1898
Atkinson, John Joseph, 7, Swiss Road, Elm Park, Fairfield, Liverpool ... ... (E) Mar. 1891
Avery, Thomas. c/o H. S. King & Co., 65, Cornhill, London, E. ... (E) Nov. 1903

B.

Baber, Samuel Ernest, "Springdale," Charlton Road, Keynshaw, Bristol ... ... (E) Nov. 1901
Baggallay, Robert, Messrs. Flannery, Baggallay & Johnson, 9, Fenchurch Street, London, E.C. ... ...(C E) May 1902
Bagnall, T. W., The Groves, Winlaton ... ...(F M) Nov. 1893
Bailey, Charles H., Tyne Engine Works, Newport, Mon. ... ... (E) Mar. 1896
Bailey, James, 3, South Avenue, Ryton-on-Tyne ... ... (E) Nov. 1884
Bailey, James N., 3, East Avenue, Benton, Northumberland ... (E) Nov. 1898
Bailey, James T., c/o Messrs. Swan Hunter & Wigham Richardson, Ltd. Neptune Works, Low Walker ... ... (E) Feb. 1899

ELECTED.

Baines, Geo. Henry, c/o Messrs. W. Gray & Co., Central Marine Engine Works, West Hartlepool ... ... (E) Oct. 1888

Baird, Alexander, 23, Roxburgh Terrace, Whitley Bay ... ... (E) Oct. 1898

Baird, George, 24, Cecil Street, North Shields ... ... (E) Oct. 1892

Baird, Robert, 13, Hylton Terrace, North Shields ... ... (E) Jan. 1890

Baker, E. F., Eng.-Lieut., R.N., Messrs. The Greenock Foundry Co., Greenock ... ... (E) { Graduate, Nov. 1892 / Member, Feb. 1898

Barber, Wm. Daglish, 10, Shipley Road, Tynemouth ... ... (S) Oct. 1902

Barley, C. J., c/o Messrs. The London Electric Supply Corporation, Stowage Wharf, Deptford, London, S.E. ...(E) { Graduate, Feb. 1885 / Member, Dec. 1886

Barr, Robert Houston, 40, Oxford Street, Barrow-in-Furness ... ... (E) { Graduate, Nov. 1901 / Member, Dec. 1903

Barrett, A., Highfield, Hutton Avenue, West Hartlepool ... (E) May 1896

Barron, T. G., Hobourne, Elswick Road, West Hartlepool ... (E) Oct. 1888

Bateman, John, Vane Terrace, Darlington ... ... (E) Mar. 1901

Batey, John Thomas, 52, Queen's Road, Jesmond, Newcastle-upon-Tyne ... ... (S) Nov. 1885

Batliboi, Jehangir Framji, 45, Forbes Street, Fort, Bombay ... (E) Dec. 1888

Baxter, J., 26, Simonside Terrace, Heaton, Newcastle-upon-Tyne (E) Nov. 1884

Beckett, W. H., Eng.-Lieut., R.N., Controllers Department, The Admiralty, Whitehall, London, S.W. .. .. (E) Dec. 1903

Bell, Geo. Arthur, 48, Crown Street, Newcastle-upon-Tyne (E) { Graduate, Oct. 1890 / Member, Jan. 1894

Bell, Joshua Robson, 40, Hill Street, Jarrow-on-Tyne ... ... (S) Mar. 1899

Bell, William, Messrs. Cleland's Slipway Co., Willington Quay-on-Tyne ... ... (E) Nov. 1888

Bennett, Percy M., Gore Court, G., Calle de Roma, Mexico City ... (E E) Dec. 1899

Berkley, A. B., 8, Camden Terrace, Clifton Vale, Bristol ... ... (E) Mar. 1887

Bertram, N. Stewart, c/o Messrs. Lillishall & Co., engine Depart., Oakingates, Shropshire ... ... (E) { Graduate, Feb. 1901 / Member, Oct. 1902

Berven, Ferdinandt, 12, Thornton Street, West Hartlepool ... (S) April 1901

Bigge, D. L. Selby, 27, Mosley Street, Newcastle-upon-Tyne ... (E E) Nov. 1894

Billetop, Torben Christian, Springfield, Lesbury Road, Heaton, Newcastle-upon-Tyne ... ... (E) Nov. 1896

Bindesböll, S. C. W., Aktieselskabet Helsingors Jernskibs- og Maskinbyggeri Helsingor, Denmark ... ... (S) Nov. 1884

Binns, Aubrey B., 42, Lovaine Place, Newcastle-upon-Tyne ... ... (E) { Graduate, Oct. 1894 / Member, Dec. 1899

Black Charles, c/o Messrs. Vacuum Oil Co., Ltd., 7, Side, Newcastle-upon-Tyne ... ... (E) Oct. 1902

Black, J., 1, Church Street, West Hartlepool ... ... (E) Nov. 1888

Black, John, 20, Waverley Terrace, Newcastle-upon-Tyne ... (E) Mar. 1904

Black, Wm., 1, Lovaine Place, Newcastle-upon-Tyne ... ... (E) Jan. 1885

Blackett, Jos. S., c/o Messrs. Smith's Dock Co., Ltd., North Shields (E) May 1903

Blackett, Walter, c/o Messrs. Hawthorn, Leslie & Co., St. Peter's Works, Newcastle-upon-Tyne ... (E) { Graduate, Nov. 1886 / Member, Nov. 1892

Blackie, Thomas Reid, Lloyd's Register of Shipping, 71, Fenchurch Street, London ... . (SUR) Nov. 1890

Blake, James, Northbrook, Linthorpe, Middlesbro' .. ... (E) Nov. 1899

Blaylock, Robert, 10, Greenbank Crescent, Darlington ... ... (F M) Dec. 1900

Blenkinsop, John N., Marine Supt. Engineer, Great-Eastern Railway, Parkeston Quay ... ... (E) Oct. 1885

ELECTED.

Blomberg, Carl A., 2262, North 19th Street, Philadelphia, Pa., United States of America ... ... (E) Oct. 1896

Blow, Charles, Beech Grove, Benton, Newcastle-upon-Tyne ... (E) Nov. 1898

Blumer, Wm., Ashbrooke Tower, Sunderland ... ... (S) Dec. 1886

Böcler, Harry, 19, Azalea Terrace South, Sunderland (S) { Graduate, Mar. 1898 / Member, Dec. 1901

Boddy, John, 96, Dock Street, Newport, Monmouthshire ... ... (E) Dec. 1888

Bodin, Lauritz M., 58, John Street, Sunderland ... ... (E & SUR) Dec. 1889

Bone, W. J., 61, Linskill Terrace, North Shields ... ... (S) Dec. 1884

Bonnyman, James Smith, 64, Plasturton Avenue, Cardiff... ... (E) Nov. 1889

Booth, Edward Spence, Box 5124, Boston, U.S. America ...(M S & N A) Oct. 1889

Borrie, Peter, 55, Bonlea Terrace, Thornaby-on-Tees ... ... (E) Nov. 1900

Borrowman, William Cameron, Wh.Sch., Strathmore, West Hartlepool ... ... (E) Oct. 1898

Bosi, Guiseppe, Presso Rastelli, Sampierdarena, Genoa, Italy (E & NA) Jan. 1894

Bowerbank, Albert W., 52, Victoria Avenue, Whitley Bay, Northumberland ... ... (E) { Graduate, Nov. 1900 / Member, Dec. 1902

Boyd, Arthur, Lloyd's Register of Shipping, Bute Docks, Cardiff(E SUR) May 1895

Boyd, Wm., North House, Long Benton, Newcastle-upon-Tyne ... (E) Nov. 1884

Boyd, William, 25, Woodbine Avenue, Gosforth, Newcastle-upon-Tyne ... ... (E) Nov. 1904

Boyt, John T., 387, Bourse Buildings, Philadelphia, Pa., U.S.A. ... (E) Nov. 1893

Bramwell, Balfour, 4, Victoria Crescent, Ravenhill Road, Belfast ... ... (E) { Graduate, Nov. 1886 / Member, Nov. 1887

Brankston, R. T., Beechcroft, Beechgrove Road, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Brigham, Robert F., 5, Argyle Terrace, South Shields ... ... (E) Mar. 1897

Broadbent, Frank, 4, Queen Street Place, London, E.C. ... ... (E E) Nov. 1893

Brock, Henry W., c/o Messrs. Wm. Denny & Bros., Dumbarton (E & S) Nov. 1899

Brockett, Charles, 35, Milton Road, West Hartlepool ... ... (E) Feb. 1899

Brookfield, J. W., Brookhurst, Halifax, Nova Scotia ... ... (N A) Nov. 1903

Brotherston, James, 23, Nelson Street, Sunderland ... ... (E) Oct. 1895

Brown, E. Eugene, c/o Messrs. J. H. Holmes & Co., Portland Road, Newcastle-upon-Tyne ... ... (E E) Feb. 1886

Brown, Geo. Matthew, c/o Messrs. The British Thompson-Houston Co., Rugby ... ... (E) { Graduate, April 1895 / Member, Nov. 1897

Brown, James, c/o Messrs. Scott & Co., Greenock ... ... (E) Mar. 1891

Brown Joseph, 26, Fern Avenue, Jesmond, Newcastle-upon-Tyne (E) May 1904

Brown, Percy J., Salem Cottage, Sunderland ... ... (E) May 1899

Brown, Robson, 32, Salmon Street, South Shields ... ... (E) Nov. 1889

Brown, T. R., 37, Stansfield Street, Sunderland ... (E) { Graduate, May 1885 / Member, Oct. 1886

Brown, William, c/o Messrs. Siemens Brothers & Co., Woolwich... (E) April 1887

Browne, Benjamin C., jun., 8, Lambton Road, Newcastle-upon-Tyne ... ... (E) { Graduate, Oct. 1898 / Member, Dec. 1901

Browne, Sir B. C., Westacres, Benwell, Newcastle-upon-Tyne (C E) Jan. 1885

Buchanan, John H., Oswald Chambers, 5, Oswald Street, Glasgow(SUR) Oct. 1888

Buckland, H. B., Baltic Chambers, Quayside, Newcastle-upon-Tyne (E) Nov. 1885

Buckwell, George William, Board of Trade Surveyor's Offices, Barrow-in-Furness ... ...(SUR) Oct. 1896

Bull, John Catharinus, Athelstane, Helensburgh ... ... (E) Oct. 1892

ELECTED.

Bulmer, A. E., Jesmond Lodge, Gidlow Avenue, Wigan (E) { Graduate, Nov. 1895 / Member, Nov. 1901

Bulmer, Frederick Charles, 29, Benwell Grove, Benwell, Newcastle-upon-Tyne ... ... (E) { Graduate, May 1894 / Member, Oct. 1895

Bulmer, John George, 34, Brighton Grove, Newcastle-upon-Tyne (E) May 1894

Bulmer, Septimus, 49, Brighton Grove, Newcastle-upon-Tyne... ... ... (E) { Graduate, May 1894 / Member, Dec. 1899

Burgess, Norval Henry, 46, North View, Heaton, Newcastle upon-Tyne ... ... (S) { Graduate, Dec. 1901 / Member, Dec. 1902

Burley, M. F., 14, Croft Terrace, Jarrow-on-Tyne ... ... (F) Nov. 1899

Burnett, Norman, C, Lombard Street, Newcastle-upon-Tyne ... (E) Oct. 1891

Bushell, Chas. A., 1, Benton Terrace, Newcastle-upon-Tyne (N A & SUR) Nov. 1893

Butterfield, George, 4, Kayll Road, Sunderland ... ... (S) Nov. 1884

Butterworth, George Herbert, 41, Brook Road, Bootle, nr. Liverpool (E) Nov. 1899

Byers, Charles, 10, The Avenue, Sunderland ... ... (E) Nov. 1902

C.

Cairns, C. W., M.Sc., c/o Mrs. Robson, 11, Beaumont Terrace, Gosforth, Newcastle-upon-Tyne ... ... (E) { Graduate, Nov. 1894 / Member, Dec. 1897

Carr, Ralph, jun., 19, Abingdon Street, Westminster, London, S.W. ... ... (E) { Graduate, Jan. 1894 / Member, Nov. 1901

Carr, Wilson Story, Collingwood Buildings, Newcastle-upon-Tyne (C E) May 1900

Cama, Nusserwanji Bomanji, Sleater Road, Tardeo, Bombay, British India ... ... (E) Dec. 1888

Cameron, Angus, c/o Messrs. Sir James Laing & Sons, Deptford Yard, Sunderland ... ... (S) Nov. 1892

Cameron, Hugh Robert, Tweed House, York Terrace, North Shields (E) Feb. 1903

Campbell, Thomas, 129, Bute Road, Docks, Cardiff ... ... (S) Mar. 1894

Canning, Chas. E., 29, Duan Terrace, Ryton-on-Tyne (S) { Graduate, Dec. 1897 / Member, Nov. 1899

Cannell, Frank, Messrs. H. Parry & Son, Lisbon ... ... (E & S) Nov. 1887

Carnegie, Alfred Q., 31, Manor House Road, Newcastle-upon-Tyne ... ... (EE) { Graduate, Nov. 1899 / Member, Dec. 1901

Carney, J. H., Glengariffe, Stow Park, Newport, Monmouth ... (E) Mar. 1897

Carney, W. H., "Oakdene," Stow Hill, Newport, Monmouthshire (S) Oct. 1902

Carstons, Samuel, Messrs. Burmeister & Wains, Maskin-og Skibsbyggeri, Copenhagen, Denmark... ... ... (S) Dec. 1887

Carter, Geo. J., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Elswick Shipyard, Newcastle-upon-Tyne ... ... (N A) Dec. 1897

Ceuvel, John L., 763, Gulgenstug, Naarden, Holland ... ... (E) Mar. 1886

Chapman, Harry Reynolds, Messrs. Clarke, Chapman & Co., Gateshead-on-Tyne ... ... (E) Mar. 1893

Charlton, T., 25, Lincoln Street, Gateshead-on-Tyne ... ... (E) Nov. 1884

Chaston, Edward Catmore, 36, St. George's Terrace, Newcastle-upon-Tyne ... ... (E) Oct. 1894

Chicken, Christopher B., Wylam House, Wylam Road, Newcastle-upon-Tyne ... ... (E) Dec. 1901

Chicken, Thomas, c/o Messrs. Newport Engineering and Ship Repairing Co., Newport, Monmouth ... ... (E) Oct. 1892

Chilton, Joseph, 4, Westbourne Terrace, North Ormsby, Middlesborough ... ... (E) Dec. 1899

ELECTE

Chisholm, Alexander, c/o Messrs. The Sunderland Shipbuilding Co., Sunderland ... ... (S) Mar. 18
Christie, C. J. D., Neptune Works, Walker-on-Tyne ... .. (S) Nov. 18
Christie, J. D., 12, Northumberland Terrace, Tynemouth ... (S) Nov. 18
Christie, Reginald, Woodside, Tynemouth ... ... (E &) Mar. 19
Clark, Charles, c/o Messrs. Robert Irvine & Co., Tower Chambers, West Hartlepool .. .. (E) Jan. 18
Clark, George, Southwick Engine Works, Sunderland ... (E) Feb. 18
Clark, Henry, Southwick Engine Works, Sunderland ... ... (E) Oct. 18
Clark, John Harwood, Messrs. Sir James Laing & Sons, Deptford Yard, Sunderland ... ... (E) Nov. 19
Clarke, Harry, Lloyd's Register of Shipping, Bank Chambers, Newport, Monmouth ... ... (E) Mar. 18
Clarke, Henry Trevisa, Deptford Shipyard, Deptford, Sunderland (S) Mar. 18
Clarke, William Henry, 21, The Terrace, Roker, Sunderland ... (E) Dec. 18
Cleghorn, Alexander, 10, Whittinghame Drive, Kelvinside, Glasgow ... ... (E) Feb. 18
Clift, Arthur S., Dynamo Department, c/o Messrs. Siemens Bros. & Co., Ltd., Woolwich ... ... (E) Nov. 19
Coates, Matthew C., 26, Denmark Street, Gateshead-on-Tyne ... (E) Nov. 18
Cohn, William M., 2, Marine Terrace, North Shields ... ... (S) Nov. 18
Coleby, James W., Churchill Street, Willington Quay-on-Tyne ... ... (E) { Graduate, Oct. 18 / Member, Jan. 18
Coleman, A. Chas., 3, Balmoral Terrace, Gosforth, Newcastle-upon-Tyne ... ... (E E) Nov. 19
Collins, Edward D., 5, Albert Terrace, Whitley Bay, Northumberland ... ... (E) Feb. 19
Common, John B. A., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ... (E) April 18
Coninck, Gaston de, 115, Thirty-second Street, Newport, News Va., U.S.A. ... .
Conràdi, Carl, Prinsens Gade 2b, Christiania, Norway ... ... (E) Nov. 18
Cookson, John A., 2, St. Edmund's Road, Gateshead on-Tyne ... ... (E) { Graduate, Dec. 18 / Member, Nov. 18
Cookson, William D., Milton House, Albert Drive, Low Fell, Gateshead-on-Tyne ... ... (E) Nov. 19
Cooper, Burjorjee S. N., Sea View, Mahim, Bombay, British India (E) May 19
Cooper, Shapoojee P., Luxmi Mills, Sholapur, British India ... (E) Apl. 19
Coote, Arthur, Messrs. R. & W. Hawthorn, Leslie, & Co., Hebburn-on-Tyne ... ... (S) Nov. 18
Cornish, H. P., Lloyd's Register of Shipping, 28, Katendyk, Ouest Quai, Antwerp ... ... E) Oct. 18
Couche, Henry Drew, 6, Alfred Road, Birkenhead ... ... (S) Oct. 18
Coull, Alex. B., Baltic Chambers, Newcastle-upon-Tyne ... ... (C E) Jan. 18
Coulson, Richard H. A., c/o Messrs. Dorman, Long & Co., Britannia Works, Middlesborough ... ... (E) { Graduate, April 18 / Member, Dec. 19
Cowan R., 14, Osborne Avenue, South Shields ... ... (E) Dec. 18
Cowens, William Edward, c/o Messrs. John Abbot & Co., Gateshead-on-Tyne ... ... (E) Dec. 18
Craggs, Ernest H., Messrs. R. Craggs & Sons, Tees Dockyard, Middlesbrough ... ... (S) Oct. 18
Craig, Robert, Pageland House, Grange Road, West Hartlepool ... (E) Nov. 18

ELECTED.

Crammond, A., Tyne Dock Entrance, Corstorphine Town, South Shields ... ... (E) Nov. 1903
Crighton, A. T., 27, Canal des Brasseurs, Antwerp ... ... (E) Apl. 1903
Crookston, John, 72, Mark Lane, London, S.E. ... ... (E) Mar. 1896
Crozier, Thomas W., c/o Messrs. Blyth Shipbuilding Co.. Blyth ... (S) Dec. 1902
Cruddas, W. D., Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Elswick, Newcastle-upon-Tyne ... ... (E) Dec. 1884
Cruickshank, Alexander, H.M. Naval Dockyard, Gibraltar .. (SUR) Mar. 1892
Cullen, Harold Rigby, M.A., Durham College of Science, Newcastle-upon-Tyne ... ... (E) Nov. 1902
Cumming, William, c/o Mr. Hyslop, Hampton House, Grey Street, St. Kilda, Melbourne, Australia ... ... (E) Mar. 1896
Cumming, William Milligan, Pape's Buildings, Pink Lane, Newcastle-upon-Tyne ... ... (E) Dec. 1903
Cummins, W. R., 15, Western Elms Avenue. Reading, Berkshire (E) Nov. 1884
Curgenven, L. W., Eng.-Lieut., R.N., c/o The Admiralty, White-Hall, London, S.W. ... ... (E) Nov. 1903

D.

Dalrymple, Alexander, 25, Rutland Avenue, Sefton Park, Liverpool (E) Nov. 1901
Dalrymple, Wm., Myrtle Cottage, nr. Cleadon, Sunderland ... (E) Dec. 1886
Dalrymple, William, Jun., 42, Cleveland Road, Sunderland ... (E) Dec. 1895
Danielsen, John William, Highfield, Farquhar Road, Birmingham... ... ... (E) { Graduate, Mar. 1899 / Member, Mar. 1902
Darling, W. J., Lloyd's Register of Shipping, Dock Chambers, Barry ... ... (S) April 1887
Darney, John, c/o Messrs. Short Bros., Pallion, Sunderland ... (S) Nov. 1884
Davidson, Alexander, 12, Hayburn Crescent, Partick, Glasgow ... (E) Nov. 1900
Deighton, William, Messrs. Deighton's Patent Flue Co., Vulcan Works, Pepper Road, Leeds ... ... (E) Nov. 1897
Denny, Archibald, c/o Messrs. Wm. Denny & Bros., Dumbarton ... (S) Dec. 1891
Denny, Leslie, c/o Messrs. Wm. Denny & Bros., Dumbarton ... (S) Nov. 1899
Denny, Peter, Bellfield. Dumbarton... ... ... (E & S) Nov. 1899
De Rusett, Edwin W., Warden House, Percy Park Road, Tynemouth ... ... (S) Nov. 1890
Detchon, John, Bamborough Terrace, North Shields ... ... (E) Feb. 1899
Dewar, John, The Green, Wallsend-on-Tyne ... ... (E) { Graduate, Nov. 1899 / Member, Mar. 1904
Dick, F. W., c/o Messrs. Park Gate Iron and Steel Co., Ltd., Park Gate, Rotherham ... ... (I & S M) Oct. 1891
Dickie, James, Falstone House, West Park, South Shields ... (S) Nov. 1901
Dickie, James, 428, Mississippi Street, Potrero, San Francisco, California, U.S.A.... ... ... (S) Mar. 1894
Dickie, John P., Falstone House, West Park, South Shields ... ... (E) { Graduate, Mar. 1898 / Member, May 1900
Dickie, Matthew D., Falston House, West Park, South Shields ... (S) Jan. 1903
Dickinson, F. T., Ashbrook Crescent, Sunderland (E) { Graduate, May 1885 / Member, Oct. 1886
Dickinson, James C., The Cloisters, Sunderland ... ... (E) Nov. 1884
Dickinson, John, Park House, Sunderland ... ... (E) Nov. 1884

ELECTED.

Dickinson, W., The Club, Sunderland ... ... (E) Nov. 1884
Dietze, F. G., Messrs. The Hamburg South American Steam Ship Company, Hamburg ... ... (E) Nov. 1893
Dippie, Joseph Robt., "Roseholme," Beaumont, South Jarrow ... (S) April 1900
Dixon, Harold Raylton, Messrs. Sir Raylton Dixon & Co., Ltd., Shipbuilders, Middlesbrough ... ... (S) May 1902
Dixon, James, c/o Messrs. Ropner & Sons, Shipbuilders, Stockton-on-Tees ... ... (E) Dec. 1893
Dixon, John Rochester, 4, St. Nicholas's Buildings, W., Newcastle-upon-Tyne ... ... (E) { Graduate, Oct. 1887 / Member, Feb. 1893
Dixon, John Thomas, 27, Meldon Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) { Graduate, Dec. 1899 / Member, Dec. 1901
Dixon, William John, Eng.-Lieut., R.N., H.M.S. "Cynthia," Mediterranean Squadron ... ... (E) { Graduate, Mar. 1896 / Member, Nov. 1899
Dobson, Henry James, c/o Messrs. William Dobson & Co., Newcastle-upon-Tyne ... ... (S) { Graduate, Oct. 1891 / Member, Feb. 1898
Dobson, Wm. G., The Chesters, Jesmond, Newcastle-upon-Tyne ... ... (S) { Graduate, Feb. 1896 / Member, Dec. 1901
Dobson, William, Shipbuilder, Walker-on-Tyne ... ... (S) Nov. 1888
Donald, James, 58, General Gordon Terrace, Sunderland ... ... (S) Nov. 1884
Donaldson, Henry B., 36, Cheltenham Street, Barrow-in-Furness ... ... (S) { Graduate, Nov. 1897 / Member, Dec. 1902
Donkin, George, St. Andrew's Engine Works, Newcastle-upon-Tyne (E) Oct. 1892
Donovan, J. W., 5, Ash Place, Newcastle Road, Sunderland ... (E) April 1885
Douglas, John F., c/o Messrs. Ramage & Ferguson, Leith... ... (E) Jan. 1888
Dove, Herbert J., 14, Lyndhurst Avenue, Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1896
owning, Nicholas, Glenbrooke, Victoria Avenue, Norton Road, Stockton-on-Tees ... ... (I F) Oct. 1894
Dowsen, Chas., 21, Croft Terrace, Jarrow-on-Tyne... ... ... (E) Dec. 1885
Dowsen, Jas. Wm., 21, Croft Terrace, Jarrow-on-Tyne ... ... (E) May 1903
Doxford, Albert Ernest, M.A., 1, Grange Crescent, Sunderland... ... ... (E) { Graduate, Oct. 1890 / Member, Nov. 1893
Doxford, Charles D., Pallion Shipyard, Sunderland ... ... (S) Nov. 1884
Doxford, Robt., jun., Silksworth Hall, Sunderland (S) { Graduate, Feb. 1897 / Member, Dec. 1901
Doxford, Robert P., Pallion Engine Works, Sunderland ... ... (E) Nov. 1884
Doxford, Sir W. Theodore, M.P., Pallion Shipyard, Sunderland ... (S) Nov. 1884
Dressler, Gustav, 21, Fischmarkt, Altrona-on-Elbe ... ... (E) Jan. 1900
Duckitt, Jno., Leazes Gate Villa, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Duckitt, John Brentnall, 179, Great Norbury Street, Hyde, Cheshire ... ... (E E) { Graduate, Oct. 1888 / Member, April 1895
Duckitt, Talbot, Hawthorndale Cottage, Paton Street, Alloa, N.B. ... ... (E E) { Graduate, Oct. 1891 / Member, Oct. 1898
Dugdale, William H., Wear Dock Yard, Sunderland ... ... (S) Mar. 1894
Duguid, Robert, c/o Messrs. Thomas Wilson & Sons, Naval Architects' Department, Hull ... ... (S) Oct. 1892
Dunlop, John, c/o Messrs. John Reid & Co., Baltic Chambers, 50, Wellington Street, Glasgow ... ... (S) Mar. 1898
Dunlop, William, 119, Schneider Terrace, Barrow-in-Furness .. (E) Mar. 1888
Dykes, George, Lloyd's Register of Shipping, Steinhoeft 3, Hamburg ... ... (S) Jan. 1893

ELECTED.

Dykes, James, 82, Park Road, Newcastle-upon-Tyne ... ... (E) May 1885
Dykes, John, Lloyd's Register of Shipping, 3, Oriental Place, Southampton ... ...(SUR) Oct. 1889

E.

Eason, Thos., 30, Rothwell Road, Gosforth, Newcastle-upon-Tyne (E) April 1899
Easthope, James, Messrs. Lloyds Register of Shipping, Ramsden Square, Barrow-in-Furness ... ... (SUR) Dec. 1903
Edminson, Frank A., Gowan Villas, Newcastle-upon-Tyne (S) { Graduate, Nov. 1893 / Member, Nov. 1897
Edmiston, Jas. B., Ivy Cottage, Highfield Road, Walton, Liverpool (E) Nov. 1886
Edwards, Robert Wm., Eng. Captain, R.N., c/o Mail Officer, H.M.S. "Hibernia," Malta ... ... (R N E) Feb. 1902
Eeles, Robert, Cathedral Buildings, Dean Street, Newcastle-upon-Tyne... ... ... (E) April 1889
Elder, Edward, c/o Messrs. Frew, Elder, & Co., 9 Queen Street, Newcastle-upon-Tyne ... ... (S) { Graduate, Nov. 1890 / Member, Oct. 1892
Elliott, Andrew, 27, Church Rord, Seaforth, near Liverpool ... (E) May 1903
Elliott, William D., Hessle, Hull ... ... (E) Nov. 1894
Eltringham, Harry, Messrs. J. T. Eltringham & Co., Stone Quay, South Shields ... ... (S) Feb. 1901
Eshelby, William, 13, Brankingham Terrace, Norton Road, Stockton-on-Tees ... ... (E) Feb. 1888
Eyres, Reginald J., 4, Cedars Crescent, Sunderland ... (C E) Feb. 1900

F

Fairbairn, Archbold, F Violet Street, South Hylton, Sunderland (E) Mar. 1902
Fairburn, William Armstrong, P.O. Box, 183, Quinay, Mass., U.S.A. (*Life Member*) ... ... (N A) (E) Nov. 1902
Fairweather, C. W., c/o Messrs. Northern Counties Electricity Supply Co., Ltd., 13, Mosley Street, Newcastle-upon-Tyne (E) Oct. 1902
Farina, A. J., 63, Quayside, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Farquharson, Geo. James, c/o Messrs. Elder, Dempster & Co., Luisenhof, Neue Gröninger Strass, 1, Hamburg ... ... (E) April 1899
Fenwick, James, B.Sc., C.E., 19, Bridge Street, Sydney, New South Wales ... ... (E) Oct. 1892
Ferguson, Wm. Deeble, 3, Mount Delphi, Antrim Road, Belfast ... (CE) Feb. 1901
Ferrier, Robert M., B.Sc., University College, Bristol ... ... (E) Nov. 1892
Ferry, S. O., 10, Malvern St., Newcastle-upon-Tyne ... ... (E) Oct. 1902
Fettes, James, c/o Messrs. R. A. Mudie & Sons, Maritime Buildings, East, Dock Street, Dundee ... ... (E) May 1899
Field, Arthur M. C., 25, Mansfield Street, Thornaby-on-Tees ... (E E) Jan. 1898
Figari, Emanuel D., c/o Messrs. Thames Iron Works Co., Ltd., S.B.D. Tidal Basin, London, E. ... ... (S) Dec. 1900
Finch, Herbert K., Greyside, St. Edmund's Road, Ipswich ... ... (E) { Graduate, Dec. 1888 / Member, Nov. 1894
Findlay, John Taylor, 6, Earls Dene, Low Fell, Gateshead (S SUR) Mar. 1902

ELECTED.

Fish, Thomas Wilson, Lloyd's Register of Shipping, 2 Hare Street, Calcutta, British India ... ...(SUR) May 1892

Fitzgerald, Arthur F., 1, Wood Terrace, South Shields (E) { Graduate, Feb. 1901 / Member, Oct. 1902

Fitzgerald, Durham W., Messrs. J. T. Eltringham & Co.. Stone Quay, South Shields ... . (S) Dec. 1900

Fletcher, Robert, Walker Forge, Walker-on-Tyne ... ...(F M) Dec. 1886

Flohr, Justus, Director der Stettiner Maschinenbau-Actien-Gesellschaft "Vulcan," Rantstrasse 9, Stettin ... ... (E) Oct. 1886

Floyd, Joseph, jun., 18, Telford Street, Bensham, Gateshead (I & S M) Mar. 1903

Ford, John McLaren, 70, Mount Pleasant, Barrow-in-Furness ... (S) Nov. 1896

Forrest, Frank, 2, Bath Terrace, Tynemouth ... ... (E E) Nov. 1901

Forster, William James, 10, Chester Street, Middlesbrough-on-Tees (NA) Dec. 1903

Foster, Henry, Greenhill, Sebastopol, near Newport, Mon. ... (E) April 1885

Foster, L. P., 113, Park Road, Newcastle-upon-Tyne (E) { Graduate, Nov. 1893 / Member. Oct. 1898

Foster, Martin, Claremont, Norton, Stockton-on-Tees ... ... (F M) Nov. 1900

Fothergill, J. R., 1, Bathgate Terrace, West Hartlepool ... ... (C E) Mar. 1886

Fowler, Jas. Speir, 27, Whitlets Road, Ayr, N.B. ... . (E) Nov. 1901

Fownes, Henry, Jarrow Hall, Jarrow-on-Tyne ... ... (F M) Nov. 1884

Fox, Carter, 32, Lish Avenue, Whitley Bay... ... (E) { Graduate, Feb. 1898 / Member, Dec. 1899

Fox, William. 9, Winfield Terrace, Chester Road, Manchester ... (E) April 1895

France, Alfred Brown, Extension Hotel, Middlesbrough ... ... (E) Feb. 1900

Franki, J. P., c/o Messrs. Morts Dry Dock and Engineering Co., Sydney, N.S.W., Australia ... ... (E) Jan. 1886

Fraser, John Holt, c/o Messrs. A. & R. Brown & Co., 90, Regent Road, Liverpool ... ... (E) { Graduate, Oct. 1895 / Member, Jan. 1898

Friederichs, Herbert F., 1, Stanhope Avenue, West Hartlepool (E E) Mar. 1901

Fuller, Philip S., 189, Cardigan Terrace, Gateshead-on-Tyne ... (E) Nov. 1899

Furness, Stephen Wilson, Messrs. Furness, Withy & Co., West Hartlepool ... ... (S) May 1904

G.

Gaine, Roger L., Hartlepool Engine Works, Hartlepool (E) { Graduate, Dec. 1887 / Member. Oct. 1894

Gannaway, H. G., 7, Oxford Terrace, Renfrew, N.B. ... ... (S) Nov 1884

Garelli, Fabio ... ... (S) Oct. 1896

Garmey, John, Prince Line, Ltd., Produce Exchange, New York... (E) Dec. 1898

Garson, Stanley T., 5, Rome Terrace, Borough Road, Middlesbrough ... ... (I M) Nov. 1902

Garthwaite, John R., c/o Messrs. R. Ropner & Sons, Stockton-on-Tees (S) May 1889

Garwood, Harry Tom, Eng. Lieut. R.N., 36 Hawthorn Street, Newcastle-upon-Tyne... ... ... (R N E) May 1903

Gates, George, 57, Ancliffe Gardens, West Hartlepool ... ... (E) Jan. 1899

Gayner, Robt. H., Jun., West Bank, Sunderland ... (E) { Graduate, Mar. 1886 / Member, Oct. 1888

Gearing, Ernest George, Penshurst, Clarence Drive, Harrogate ... (E) Dec. 1892

Geddes, Christopher, 2A, Drury Lane, Water Street, Liverpool ... (E) Oct. 1888

Geddes, Frank, The Grove, Shotley Bridge, Co. Durham ... ... (E) Mar. 1902

ELECTED.

Giacomuzzi, Virgilio, c/o Messrs. Nicolo Odero fu Alessandro, Sestri-Ponenti, Italy ... ...(N A) Nov. 1899

Gibson, H., 162, Roker Avenue, Monkwearmouth, Sunderland ... (S) Nov. 1884

Gibson, J. Hamilton, c/o Messrs. Laird Bros., Birkenhead Iron Works, Birkenhead ... ...(E) Graduate, April 1891; Member, Oct. 1894

Gibson, W. H., 37, Tatham Street, Sunderland ... ... (E) Nov. 1884

Glahome, John William, 28, Cartington Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1899; Member, Aug. 1903

Golledge, William, c/o Messrs. Aublet, Harry & Co., 53, Curtain Road, London, E.C. ... ... (E E) Graduate, Nov. 1891; Member, Nov. 1896

Good, Farrant, Beer, near Axminster, Devon ... ... (E) Mar. 1896

Gordon, William James, c/o Messrs. Vickers, Sons & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (E) Oct. 1887

Gordon, William Leslie, Invermark, Broughty Ferry, N.B. ... (E) April 1893

Graham, James Thos., 126, Westmorland Road, Newcastle-upon-Tyne ... ... (E) Nov. 1897

Graham, Joseph S., Morro House, Syon Street, Tynemouth ... (S) Feb. 1903

Graham, William, West House, Tynemouth ... ... (S) Oct. 1891

Graham, William, 30, Hill Street, Jarrow-on-Tyne... ... ... (S) April 1893

Graham, William, Rockcliffe, Redbrink Crescent, Barry Island, South Wales ... ... (E) Nov. 1894

Gravell, John, Bureau Veritas Register of Shipping, 155, Fenchurch Street, London, E.C. ... ... (N A SUR) Nov. 1884

Gray, A., 1, South Parade, Newcastle-upon-Tyne ... ... (E) Nov. 1888

Green, J. W. ... ... (I & S M) May 1901

Green, W. G., Churchill Street, Willington Quay-on-Tyne ... (E) Nov. 1884

Grey, Robert, 67, De Grey Street, Newcastle-upon-Tyne ... ... (E) Nov. 1903

Griffith, Edwin, Messrs. The Wallsend Slipway and Engineering Co., Wallsend-on-Tyne ... ... (E) Nov. 1897

Grimes, Thomas Benjamin, 39, Vespasian Avenue, South Shields... (E) Mar. 1890

Gulston, A., Clayton Park Lodge, Jesmond, Newcastle-upon-Tyne (E) Dec. 1888

Gunn, Sir John, Chairman, Messrs. Mount Stuart Dry Docks Co., Cardiff (*Life Member*) ... ... June 1896

Gunter, John Henry, c/o Messrs. Dorman, Long & Co., Ltd., Britannia Steel Works, Middlesbro' ... ... (I & S M) Oct. 1902

Guyate, E. G., Eng.-Lieut., R.N., H.M.S. "Nelson," Portsmouth... (E) Nov. 1903

H.

Hall-Brown, Ebenezer, St. Helens Engine Works, Govan, Glasgow (E) May 1902

Hall, Edward, 68, Grange Road West, Jarrow-on-Tyne ... ... (S) Nov. 1885

Hall, F. M., 8, Wentworth Terrace, South Shields ... ... (C E) Nov. 1903

Hall, J. Percy, Carville, Lawrie Park Road, Sydenham, London, S.E. (E) Oct. 1885

Hall, John, 54, Westoe Parade, South Shields ... ... (E) May 1900

Hall, Thomas, 29, Selbourne Road, Ilford, London, E. ... ... (E) Nov. 1899

Hamilton, Andrew, 19, James Street, Liverpool ... ... (C E) April 1901

Hamilton, James, Beech House, Mile End, Stockport (E) Graduate, Nov. 1897; Member, Dec. 1901

Hammar, Hugo G., Lindholmens, Verkstads Alstieholag, Göteberg, Sweden ... ... (S) Nov. 1890

Hammersley, B. J., c/o Messrs. Tyne Brass and Copper Tube Manufacturing Co., Jarrow-upon-Tyne ... ... (E) May 1901

ELECTED.

Hammond, Fleetwood C., c/o Messrs. Cowpen Coal Co., Ltd., Cowpen Colliery, Blyth ... ... (E) Graduate, Nov. 1899; Member, Dec. 1901

Haramüshi, M., Jun., Mitsubishi Dockyard and Engine Works, Nagasaki, Japan ... ... (N A) Nov. 1897

Harbottle, Thomas, 5, Alexandra Terrace, Newcastle-upon-Tyne (E) Jan. 1900

Hardy, Henry Thomas, 105, Cleveland Road, Sunderland ... ... (S) Dec. 1899

Harkness, Richard, Grange Road, West Hartlepool ... (S SUR) Nov. 1884

Harlow, F., 8, Benton Terrace, Newcastle-upon-Tyne ... .. (E) Nov. 1884

Harman, Bruce, Messrs. The Linde British Refrigerating Co., 35, Queen Victoria Street, London, E.C. ... ... (E) Oct. 1886

Harper, J. H., 1, Beaumont Street, North Shields ... ... (E) Jan. 1885

Harris, Anthony, 73, Queen Victoria Street, London, E.C. ... (E) Mar. 1892

Harris, John .. .. (E) Dec. 1902

Harrison, Alfred, c/o Messrs. Richardsons, Westgarth & Co., Scotia Engine Works, Sunderland (*Life Member*) ... (E) Oct. 1889

Harrold, Alexander, 26, Park Road, Newcastle-upon-Tyne ... (E) Nov. 1884

Harrold, F., 12, The Woodlands, Hexham ... ... (E) Nov. 1888

Harroway, George Mitchell, 18, West Terrace, North Ormesbey, Middlesbrough ... ... (S) Jan. 1896

Hartley, W. A., c/o Messrs. Charles Cammell & Co., Cyclops Works, Sheffield ... ... (E) Jan. 1898

Harvey, John W. J., 1, Richmond Villa, Chertsey Road, Redland, Bristol ... ... (E) Feb. 1889

Hastings, Jas. F. A., Eng.-Lieut., R.N., c/o Rev. W. Hastings, Maidwell Rectory, Northampton ... ... (E) Nov. 1903

Haswell, Wm. Spence, c/o Messrs. Tangye, Ltd., 3, St. Nicholas Buildings, Newcastle-upon-Tyne ... ... (E) Oct. 1900

Haussman, B., c/o Messrs. Borneo Co., Limited, 28, Fenchurch Street, London E.C. ... ... (E) Feb. 1899

Hay, John, "Wansfell," The Grove, Finchley, London, N. ... (E) Nov. 1901

Hayashida, N., c/o Mitsubishi Dockyard & Engine Works, Nagasaki, Japan ... . (E) Oct. 1902

Hayhurst, James, 41, Warrington Road, Newcastle-upon-Tyne .. (C E) Nov. 1901

Head, William, Manager, Victoria Shipyard, Goole ... ... (S) Feb. 1901

Headlam, Robert, New Park Terrace, Hartburn Lane, Stockton-on-Tees ... ... (E) Nov. 1886

Heck, John H., Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (S SUR) Nov. 1885

Henderson, Alex., 11, Rua Nova do Almada 1°, Lisbon ... ... (E) April 1893

Henderson, A. M., 3, Greatham Terrace, West Hartlepool ... (E) Nov. 1890

Henderson, George, 54, Westmorland Road, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Henderson, John, c/o Messrs. A. Henderson & Co., Mount Stewart Square, Cardiff ... ... (E) June 1896

Henderson, J. R., 3, Humbledon View, Sunderland ... ...(SUR) Oct. 1902

Henry, William P., Cragside, St. Aidan's Road, South Shields ... (E) April 1897

Henshall, Samuel, c/o Messrs. Sir Raylton Dixon & Co., Middlesbrough ... ... (S) Graduate, May 1885; Member, Jan. 1894

Hepburn, Alfred, c/o Messrs. N.E. Marine Engineering Co., Northumberland Forge, Wallsend-on-Tyne ... ... (F M) Dec. 1890

Hepburn, James M., 17, Grosvenor Place, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1895; Member, Dec. 1901

ELECTED.

Hesketh, Thomas, Bryn Tirion, Richmond Road, Cardiff ... ...(SUR) April 1896
Heslop, Thomas, 6, Eldon Place, Newcastle-upon-Tyne ... ... (E) Dec. 1900
Hetherington, William, 2, Ewesley Road, Sunderland ... ... (S) Dec. 1899
Hewison, Herbert, 113, Woodbine Avenue, Wallsend-on-Tyne ... (S) Dec. 1900
Higginbotham, George Emerton, 4, Fairfield Crescent, Fairfield, Liverpool ... ... (E) Nov. 1900
Higgins, C. F., c/o Messrs. T. Richardsons, Westgarth & Co., Hartlepool Engine Works, Hartlepool... ... ... (E E) Feb. 1898
Hildrey, A. J., 11, Newcastle Road, Sunderland ... ... (S) Nov. 1884
Hills, Lawrence. 2, Somerset Terrace, East Bolden, Newcastle-upon-Tyne ... ... (S) { Graduate, Nov. 1898 / Member, Dec. 1901
Hinchliffe, Robert, 29, Lish Avenue, Whitley Bay, Northumberland ... ... (S) { Graduate, Nov. 1893 / Member, Oct. 1898
Hirst, Richard, 25, Brougham Terrace, West Hartlepool ... (E SUR) Nov. 1885
Hodge, Rowland F. W., c/o Messrs. The Northumberland Shipbuilding Co., Limited, Northumberland Shipyard, Howdon-on-Tyne ... ... (S) Dec. 1890
Hogarth, G. V., 32, Water Lane, Maryland Point, London, E.C. (S) May 1900
Hogg, Archibald, Welbeck Road, Walker-on-Tyne ... ... (S) Jan. 1897
Hogg, James, 8, Lovaine Terrace, North Shields ... ... (B F) Nov. 1889
Hogg, Thomas 8, Lovaine Terrace, North Shields ... ... (E) Feb. 1903
Hök, Wilhelm, 10, Karlaplan, Stockholm, Sweden ... ... (S) Oct. 1886
Hollis, Henry E., 40 Union Street, Glasgow ... ... (I & S M) Feb. 1858
Holmes, John H., Wellburn, Jesmond Dene Road, Newcastle-upon-Tyne ... ... (E E) Jan. 1888
Houston, John, 7 Thornhill Crescent, Sunderland ... ... (E) Nov. 1894
Hughes, Thos. Charles, 8, Oxnam Crescent, Spital Tongues, Newcastle-upon-Tyne ... ... (E) { Graduate, Nov. 1893 / Member, Nov. 1897
Humphreys, George, 24, Mayfield Road, Gosforth, Newcastle-upon-Tyne ... ... (E) Jan. 1902
Hunt, Allen E., 11, St. Cuthbert's Terrace, Bensham, Gateshead (SUR) Feb. 1901
Hunter, George B., Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne ... ... (S) Nov. 1884
Hunter, George Ernest, Aykleyheads, Durham ... (S) { Graduate, Feb. 1898 / Member, Nov. 1899
Hunter, Joseph Gilbert, Lloyds Register of Shipping, P.O. Box No. 671, Newport News, Va., U.S.A. ... ... (SUR) Feb. 1900
Hunter, J. W., 22, Argyle Square, Sunderland ... ... (E) May 1885
Hunter, Summers, c/o Messrs. N.E. Marine Engineering Co., Northumberland Engine Works, Wallsend-on-Tyne ... ... (E) Nov. 1885
Hutchinson, C. W., 6, Park Parade, Westmoreland Road, Newcastle-on-Tyne ... ... (E) Nov. 1884
Hutchison, J., Board of Trade Offices, Middlesbrough ... ...(SUR) Dec. 1891
Hutchinson, Wesley, B.A., 6, Park Parade, Westmoreland Road, Newcastle-on-Tyne ... ... (E) Oct. 1891
Hyslop, Alfred M., c/o Messrs. Boothroyd, Hyslop & Co., Akenside Street, Bootle, Liverpool ... ... (E) Mar. 1900

1.

Inglis, John, c/o Messrs. Hawthorn & Co., Leith ... ... (S) April 1887
Inglis, John, LL.D., Pointhouse Shipyard, Partick, Glasgow (E & S) Oct. 1886

ELECTED.

Ions, Thos. R., 11, Newcastle Street, North Shields ... ... (E) May 1903
Irvin, Matthew B., Mustapha Pasha, Ramleh, Alexandria, Egypt (E) Oct. 1900
Irwin, J. H., Mowbray Terrace, Sunderland ... ... (E) Nov. 1884
Ito, Kumezo, Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan ... ... (E) Dec. 1900

J.

Jack, William C., c/o F. Espin, Esq., 3, East India Avenue, London, E.C. ... ... (E) Nov. 1894
Jackson, William S., Messrs. Gourlay Bros. & Co., Camperdown Shipyard, Dundee... ... ... (S) April 1891
James, M. C., 39, Beverley Terrace, Cullercoats ... ... (S) Nov. 1884
James, Wm. E., 39, Beverley Terrace, Cullercoats... (S) { Graduate, May 1899 / Member, Nov. 1903
Jarvis, Harry Robert, 14, Burnfoot Terrace, Whitley Bay, Northumberland ... ... (S) Feb. 1901
Jarvis, Horace William, West Dyke, Coatham, Redcar ... ... (E) May 1902
Jobling, W. J., 7, The Side, Newcastle-upon-Tyne ... ... (E & S O) Nov. 1884
Jobling, Vivian, 11 Belle Grove West, Spital Tongues, Newcastle-upon-Tyne ... ... (NA) { Graduate, Oct. 1898 / Member, Mar. 1904
Jobson, Robert, Jun., Rhenass, Clifton Avenue, West Hartlepool (S) Feb. 1898
Johnson, Alexander A., Bank Chambers, Sandhill, Newcastle-upon-Tyne ... ... (E) Feb. 1893
Johnson, Johan, 7, Vestra Hamngaten, Gothenburg, Sweden ... (S) May 1885
Johnson, Joseph, Bentham Buildings, Side, Newcastle-upon-Tyne (E) May 1901
Johnson, T. Allan, 64, Cathedral Road, Cardiff ... ... (S) Nov. 1884
Johnstone, William, Lloyd's Register of Shipping, 14, Cross-shore Street, Greenock ... ...(SUR) Nov. 1884
Jones, Arthur P., 72, Grosvenor Road, Jesmond, Newcastle-upon-Tyne ... ... (E) April 1903
Jones, George, c/o Messrs. W. Gray & Co., Shipyard, West Hartlepool ... ... (S) Oct. 1888

K.

Kapadia, Framjee Dorabjee, c/o Messrs. The Ahmedabad Ginning & Manufacturing Co., Ahmedabad, British India ... ... (E) Feb. 1903
Keene, H. R., Lloyd's Register of Shipping, Ouest Quai, 28, Katendyk, Antwerp ... ... (E) { Graduate, May 1885 / Member, April 1887
Kelly, A. Wardle, 94, Kingsley Terrace, Newcastle-upon-Tyne ... (E) Oct. 1902
Kendall, Stonard O., Lloyd's Register of Shipping, Ramsden Square, Barrow-in-Furness ... ...(SUR) Mar. 1891
Kennedy, William, 14, Gladstone Street, Hartlepool ... ... (E) April 1900
Kerfoot, James, Rue Osy, 20, Antwerp ... ... (E) Oct. 1892
Kerr, Robert, Bank Chambers, Mosley Street, Newcastle-upon-Tyne ... ... (E) Oct. 1902
King, John, Surveyor's Office, Board of Trade, Liverpool ... ... (S) { Graduate, Dec. 1890 / Member. Oct. 1892
Kirby, John Storm, 4, Westoe Terrace, South Shields ... ... (E) Mar. 1899
Kirkaldy, John, 21, Ground Floor, Leadenhall House, 101, Leadenhall Street, London, E.C. ... ... (E) Nov. 1885

ELECTED.

Kitching, J. F., 134, Fenchurch Street, London, E.C. ... ... (E) Nov. 1890
Knox, Robert, 14, West Avenue, Gosforth, Newcastle-upon-Tyne (NA) Dec. 1903
Kremesek, M. E. J., 47. Storey Square, Barrow-in-Furness ... (E) Feb. 1904
Kyle, Norman M. W., Norwood, West Avenue, Gosforth, Newcastle-upon-Tyne ... ... (E) Nov. 1898

L.

Lace, Basil T., Llanbedr Hall, near Ruthin, N. Wales (E) { Graduate, Nov. 1895 / Member, Nov. 1897
Laws, B. C., Messrs. Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (NA) Nov. 1903
Laidler, William ... ... (E) Nov. 1901
Laing, Andrew, c/o Messrs. Wallsend Slipway and Engineering Co., Wallsend-on-Tyne ... ... (E) Oct. 1892
Laing, Hugh, Deptford Shipyard, Sunderland ... ... (N A) April 1897
Laing, John, 5, Tynemouth Road, Heaton, Newcastle-upon-Tyne (E) Nov. 1884
Lamberti, James, 271, Albert Road, Jarrow-on-Tyne ... ... (E) May 1904
Landreth, Cowen, 34, Simonside Terrace, Newcastle-upon-Tyne ... (E) Mar. 1896
Larkin, James, Tyne View, East Jarrow-on-Tyne ... ... (E) Nov. 1884
Latta, James G., 78, Billiter Buildings, Billiter Street, London, E.C. ... ... (C E) Mar. 1902
Le Rossignol, Alfred Ernest, 8, Victoria Square, Newcastle-upon-Tyne ... ... (E E) Nov. 1902
Leach, Thos. A. Wm. ... ... (E) May 1903
Leathard, Thomas Surtees, 9, Otto Terrace, Sunderland ... ...(SUR) April 1899
Lee, Hugh Warren, 88, Manor House Road, Jesmond, Newcastle-upon-Tyne ... ... (E) { Graduate, Dec. 1899 / Member, Jan. 1902
Lees, Charles, Loanda, Shirehampton, near Bristol ... ... (E) Oct. 1902
Lewins, Frank, Roschill, Willington-on-Tyne ... ... (E) Dec. 1895
Liddell, J., c/o Messrs. W. Denny & Co., Engine Works, Dumbarton... ... ... (E) Nov. 1884
Lie, Gotfred, Det Bergenske Dampskibsselskab, Bergen ... ... (E) Jan. 1895
Lindberg, George, Studsgarden 8, Stockholm ... ... (N A & C E) Nov. 1901
Lindfors, Hugo, Surveyor to Lloyd's Register of Shipping, 16 Alexandersgatan, Helsingfors, Finland ... ... (SUR) May 1889
Lineham, Wilfrid J., Jesmond, 21, Newstead Road, Lee, London, S.E. ... ... (E) Oct. 1890
Link, Rolls Percival, 273, Cleveland Street, Birkenhead ... ... (C E) Mar. 1901
Lishman, John J., Jun., 16, Lovaine Place, North Shields ... ... (E) { Graduate, Dec. 1892 / Member, May 1900
Little, Frank, Ward's Buildings, High Bridge, Newcastle-upon-Tyne ... ... (E E) April 1902
Littleboy, Chas. Wm., The Woodlands, Saltburn-by-the-Sea ... (S) Oct. 1887
Littledale, John W. E., c/o Messrs. London Electric Supply Co., L.C.C. Tramways Power Station, Deptford, London, S.E. ... (E) May 1896
Livingston, Thos. L., Dunedin House, Jarrow-on-Tyne ... ... (S) Nov. 1884
Lohmeyr, H. G. C., 53, Crown Street, Newcastle-upon-Tyne ... (E) Nov. 1884
Long, A. E., 130, Albert Road, Jarrow-on-Tyne ... ... (S) Nov. 1884
Lonnon, W., Eng.-Com.. R.N., 93. London Road, Portsmouth ... (E) Nov. 1903
Loveridge, Wm. Henry, York Road, West Hartlepool ... ... (E) Feb. 1901

ELECTED.

Lowdon, John, Messrs. The Barry Graving Dock and Engineering Co., Limited, Barry Dock, near Cardiff ... ... (E) Dec. 1891
Lowes, J. Alfred, Maritime Buildings, St. Thomas Street, Sunderland (E) Dec. 1903
Lumley, Gascoigne, Bonny, Southern Nigeria ... ... (E) Nov. 1901
Lund, Pearson, Messrs. Noble & Lund, Northern Machine Tool Works, Felling-on-Tyne ... ... (E) Nov. 1900

M.

MacColl, Hector, Kirkliston Drive, Bloomfield, Belfast ... ... (E) Dec. 1890
MacColl, Hugo, Wreath Quay Engineering Works, Sunderland (*Life Member*) ... ... (E) Nov. 1896
Maccoy, John, Springfield, Gateshead-on-Tyne ... ... (E) Feb. 1886
Macdonald, Charles, 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ... ...(SUR) Feb. 1898
MacDonald, David R., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Newcastle-upon-Tyne (S) Nov. 1891
Macdonald, John C., c/o Messrs. Workman, Clark & Co., Ltd., Engine Department, Belfast ... ... (E) Nov. 1899
MacDonald, John, 9, York Street, Glasgow ... ... (E) Dec. 1900
Mace, W., 253, Albert Road, Jarrow-on-Tyne ... ... (E) Jan. 1886
Macfarlane, Archibald P., 15, Beacon Street, Low Fell, Gateshead-upon-Tyne ... ... (E) Mar. 1902
Macgregor, W. L., Board of Trade Surveyors' Offices, Blyth ...(SUR) Mar. 1899
MacHaffie, John, 635, Terrace Place, Schenectady, New York, U.S.A. (E) Dec. 1885
Mackay, William, 15, Camperdown Road, Scotstoun, Renfrewshire ... ... (S) Mar. 1892
Mackley, Edward N., 97, Enfield Road, Elswick, Newcastle-upon-Tyne... ... ... (E) April 1901
MacMillan, H. M., B.Sc., 58, Fern Avenue, Jesmond, Newcastle-upon-Tyne ... ... (S) Jan. 1902
Mail, M., Jun., c/o Messrs. Middle Dock and Engineering Co., South Shields ... ... (E) Nov. 1897
Male, Francis John, 12, Normanby Terrace, Gateshead-on-Tyne ... (E) Nov. 1902
Manaira, Guiseppe, c/o Messrs. The Cantiere Navale di Muggiano, Spezia, Italy ... ... (E & N A) Nov. 1893
Manning, Henry Lewis, E. Lieut., R.N., H.M.S. "Pioneer," Mediterranean Station ... ... (R N E) Dec. 1900
Marr, James, c/o Messrs. J. L. Thompson & Sons, North Sands Shipyard, Sunderland ... ... (S) Nov. 1884
Marshall, Frank T., Messrs. R. & W. Hawthorn, Leslie & Co., St. Peter's, Newcastle-upon-Tyne ... ... (E) { Graduate, Jan. 1885 / Member, Oct. 1888
Marshall, R. J., 53, Larkspur Terrace, Jesmond, Newcastle-upon-Tyne... ... ... (E) Mar. 1887
Marshall, Robert. Board of Trade Surveyor's Office, West Hartlepool ... ... (SUR) Mar. 1901
Martin, William. 26, Beech Avenue, Whitley Bay ... ... (E) Oct. 1902
Maslen, Frank E., The Priory, Hampstead Heath, London, N.W. ... ... (E) { Graduate, Nov. 1891 / Member, May 1898
Mason, George F., Lloyds' Bank Buildings, Mount Stuart Square, Cardiff ... ... (E) Oct. 1895

ELECTED.

Mather, Charles, 60, St. George's Terrace, Newcastle-upon-Tyne (SUR) Oct. 1888

Mather, Clifford Basil, Lesbury House, Lesbury, R.S.O. (NA) { Graduate, Oct. 1892 / Member, Oct. 1898

Mather, Thomas Brewer, 13, Park Avenue, Whitley Bay, Northumberland ... ... (CE) Nov. 1898

Matheson, William, c/o Messrs. R. & W. Hawthorn, Leslie & Co., Hebburn-on-Tyne... ... ... (S) Dec. 1889

Mathieson, Donald, 30, Jackson Street, Sunderland ... ... (E) Nov. 1898

Matthews, A. ... ... (S) Nov. 1884

Matthews, Jas., c/o Messrs. R. & W. Hawthorn, Leslie & Co., Forth Banks, Newcastle-upon-Tyne ... ... (E) Oct. 1886

Maughan, Philip A., 8, Ashleigh Grove, West Jesmond, Newcastle-upon-Tyne ... ... (S) Dec. 1900

Maxwell, Thomas, 15, Ashfield Terrace, East, Newcastle-upon-Tyne ... ... (E) Nov. 1899

Maxwell, William Ward, B.Sc., Messrs. H. Charlton & Co., Engineers, Gateshead-on-Tyne ... ... (E) Dec. 1896

McBride, William, Hartburn, Cleveland Road, Hartlepool ... (E) Dec. 1894

McCoull, Cecil, 7, Lewisham Road, Highgate Road, London, N.W. .. .. (EE) { Graduate, Oct. 1895 / Member, Dec. 1901

McGillivray, Peter, 14, Normanton Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1899

McGlashan, Arch., Beechcroft, Clifton Avenue, West Hartlepool (S) Nov. 1885

McGregor, Duncan, 31, Argyle Street, Hebburn ... ... (S) Dec. 1899

McIlvenna, J. G., c/o Messrs. The Tyne Pontoons and Dry Docks Co., Wallsend-on-Tyne ... ... (S) Nov. 1884

McKechnie, James, Messrs. Vickers, Sons & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (E) April 1896

McKenna, Francis, c/o Messrs. E. F. Wailes & Co., 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ... (E) { Graduate, Dec. 1890 / Member, Dec. 1896

McKlintock, E. E., Tyne Commissioners, Howdon Yard, Howdon-on-Tyne ... ... (E) Nov. 1903

McLaren, Robert M., Lloyd's Register of Shipping, 321, The Bourse, Philadelphia, U.S.A. ... ... (S) Nov. 1893

McLaren, William, 16, Rock Park, Rock Ferry, Cheshire ... ... (E) Oct. 1894

McLean, John H. K., Abey House, Plotina Terrace, South Shields (S) Mar. 1897

McLellan, William, Collingwood Buildings, Newcastle-upon-Tyne (CE) Feb. 1903

McNab, Andrew P. W., Lloyd's Registry of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (SUR) May 1903

McNeil, Thomas Young, Ship Drawing Office, Messrs. John Brown & Co., Clydebank, Glasgow ... ... (S) Oct. 1895

McRae, Thomas, 16, Western Hill, Sunderland ... ... (S) Dec. 1900

Meagher, H. L., 86, Park Road, Newcastle-upon-Tyne ... .. (E) Dec. 1896

Mechan, Henry, Scotstoun Ironworks, Scotstoun, Glasgow ... (E) May 1898

Meldrum, Michael, Humbledon View, Sunderland ... ... (E) Dec. 1893

Mellanby, Alex. Lawson, B.Sc., 33, Keppel Road, Chorlton-cum-Hardy, Manchester... ... ... (E) { Graduate, Dec. 1894 / Member, Oct. 1896

Melville, James, Duke Street, Barrow-in-Furness ... (E) { Graduate, Feb. 1900 / Member, Jan. 1902

Merz, Charles H., 28, Victoria Street, Westminster, London, S.W. (CE) Feb. 1903

Metcalf, Thos., 18, John Street, Sunderland... ... (S) { Graduate, May 1885 / Member, Nov. 1893

ELECTED.

Metcalfe, C. S., 24, Croft Avenue, Sunderland ... ... (E) Nov. 1884
Meuwissen, J., 18, Esplanade, Whitley Bay, Northumberland ... (E) Nov. 1899
Micheli, Pietro, Jun., Via Sottoripu, No. 1, piano nobile, Genoa, Italy ... ... (E & N A) Oct. 1888
Middlemass, Thomas, 3, Albert Place, Norton Road, Stockton-on-Tees... ... ... (S) Oct. 1889
Middleton, H., 20, Lynnwood Avenue, Newcastle-upon-Tyne (I & S M) Jan. 1893
Middleton, Robert Alexander, 20, The Grove, Benton, near Newcastle-upon-Tyne ... ... (N A) Oct. 1892
Millar, Thos., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Walker-on-Tyne ... ... (S) Nov. 1884
Milne, Geo. M., 18 Kirton Park Terrace, North Shields (E) { Graduate, Feb. 1898 / Member, Nov. 1903
Milton, James Edward, Messrs. Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ...(SUR) Nov. 1900
Milton, J. T., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ... (E SUR) Nov. 1886
Mitchell, Wm., 61, Nelson Street, Willington Quay-on-Tyne (S) { Graduate. Jan. 1898 / Member, Feb. 1901
Moffatt, William Graham, 44, Lennox Avenue, Scotstoun, Glasgow (E) Mar. 1899
Moffitt, George, c/o Messrs. The Blyth Shipbuilding Co., Blyth ... (S) Oct. 1888
Moncrieff, John M., 1, St. Nicholas' Buildings, Newcastle-upon-Tyne .. .. (C E) Dec. 1899
Moody, Thomas V., c/o Messrs. Scott Bros., 46, Sandhill, Newcastle-upon-Tyne ... ... (E) Dec. 1887
Moore, Wm. Henry, c/o Messrs. Workman, Clark, & Co., Engine Works, Spencer Basin, Belfast ... ... (E) Nov. 1897
Morgan, John Osborn, Bank Chambers, Sandhill, Newcastle-upon-Tyne... ... ... (CE) Feb. 1901
Morgan, W. H., 22, Rochdale Street, Wallsend-on-Tyne ... ... (E) Nov. 1884
Morgan, William George, 10, Rue du Bastion, Antwerp ... ... (S) May 1903
Morison, D. B., Hartlepool Engine Works, Hartlepool ... ... (E) Feb. 1885
Mörk, Peter, 31, Holsteinsgude, Copenhagen ... ... (E) Nov. 1884
Moroney, E. F., 115, Warton Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) { Graduate, Feb. 1892 / Member, Nov. 1899
Morrison, Robt., Castle View, Kirkby Stephen, Westmoreland ... (E) Nov. 1886
Morrison, William, Lloyd's Register of Shipping, Maritime Buildings, Dundee ... ... (E SUR) Oct. 1890
Morton, John, 7, Hillside, Tunstall Road, Sunderland ... ... (E) Nov. 1902
Morton, Richard Fraser, Lloyd's Register of Shipping, 24, George Street, Sheffield ... ... (E SUR) Oct. 1890
Moss, William, Kirkview, Shipley, Yorkshire ... (E) { Graduate, Jan. 1898 / Member, Dec. 1901
Mould, Francis H., 37, Hawthorn Road, Gosforth, Newcastle-upon-Tyne ... ... (E) { Graduate, Feb. 1892 / Member, Jan. 1897
Mountain, William Chas., Messrs. Ernest Scott, Mountain, & Co., Close, Newcastle-upon-Tyne ... ... (E E) Feb. 1889
Mudd, Percival Arthur, Greencliffe, Hartlepool ... (E) { Graduate, Oct. 1900 / Member Oct 1902
Mudie, James Herbert ... ... (E) Dec. 1902
Muir, Alfred Edward, Messrs. J. L. Thompson & Sons, North Sands Shipyard, Sunderland ... ... (S) Mar. 1893

ELECTED.

Muir, Robert, 11, Clarence Crescent, Whitley Bay, Northumberland ... ...(SUR) Oct. 1886
Muir, Robert Home, 1, Lovaine Crescent, Newcastle-upon-Tyne ... (S) Oct. 1892
Mulherion, G. F., Birtley Avenue, Tynemouth ... ... (S) Nov. 1884
Munck, Ove. Holger, c/o Messrs. Burmeister & Wain, Shipbuilders, Copenhagen, Denmark ... ... (S) Feb. 1899
Murdock, Thomas Plunkett, 23, Lovaine Crescent, Newcastle-upon-Tyne ... ... (E) Jan. 1904
Murray, Charles W., c/o Messrs. Babcock & Wilcox, Ltd., Ogle House, Farringdon Street, London, E.C. ... ... (E) May 1901
Murray, Councillor W., 30, Simonside Terrace, Newcastle-upon-Tyne ... ... (E) Oct. 1902
Murray, David, 17, Denwick Terrace, Tynemouth ... ... (E) Nov. 1903
Myles, David, c/o Messrs. N.E. Marine Engineering Co., Northumberland Engine Works, Wallsend-on-Tyne ... ... (E) Nov. 1884

N.

Nastoupil, John, Chief Engineer, Austro-Hungarian Navy, Marine Casino, Pola, Austria ... ... (E) Nov. 1890
Neill, William Reid, 15, Salem Hill South, Sunderland ... ... (E) Dec. 1897
Nelson, George, c/o Messrs. Blyth Foundry and Engineering Co., Blyth ... ... (E) { Graduate, Jan. 1900 / Member, Dec. 1901
Nevins, William, Hazel Rrae, Bradford Road, Shipley, Yorkshire (E) Mar. 1894
Nevison, Thomas C., 18 Milton Road, West Hartlepool ... ... (E) April 1900
Nicholls, H. E.. 25, Churchill Street, Sunderland ... ... (E) Nov. 1893
Nichols, Walter W., Clovelly, Glebe Road, Peterborough ... ... (E) May 1895
Nicholson, Charles Muirhead, 67, Meldon Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Feb. 1904
Nicholson, John S., North View, Mowbray Road, Westoe, South Shields ... ... (E) Nov. 1893
Nicholson, P. F., c/o Messrs. R. & W. Hawthorn, Leslie, & Co., Hebburn-on-Tyne ... ... (S) Feb. 1901
Nicholson, Thos. Head, 90, Rye Hill, Newcastle-upon-Tyne ... (E) Nov. 1897
Nicol, John M., 15, Linskill Terrace, North Shields ... ... (E) Nov. 1884
Nicolson, G. C., H.M.S. "Stag," Malta ... ... (E) { Graduate, Oct. 1885 / Member, Oct. 1888
Niven, William A., 7, Guildford Place, Heaton, Newcastle-upon-Tyne... ... ... (E) Nov. 1898
Nixon, John R, c/o Messrs. Blyth Shipbuilding Co., Ltd., Blyth ... ... (S) { Graduate, Feb. 1898 / Member, Oct. 1902
Noble, Harry, Northern Machine Tool Works, Brewery Lane, Felling-on-Tyne .. .. (E) Nov. 1888
Nodder, Joseph, 350, Fulwell Road, Sheffield ... . (F M) May 1893
Norman, W. S., White House, Whitby, near Chester ... ... (E) Nov. 1884
Norton, Harold P., P.O. Box 458, Stratford, c/o Messrs. P. R. Scott, Fairfield & Co., Connecticut, U.S.A. ... ... (E) Oct. 1890
Noton, F. R., Lloyd's Register of Shipping, 342, Argyle Street, Glasgow ... ... (S) Nov. 1884
Nunes, Enrique E., 1063 Calle Beretti, Buenos Ayres ... .. (E) April 1891

O.

		ELECTED.
Oliver, John Wm., 31, Baring Street, South Shields	(E)	Dec. 1900
Olsen, Hans B., jun., Victoria Road, West Hartlepool	(E)	Graduate, Feb. 1895 Member, Feb. 1902
O'Neil, J. J., 2, Erith Terrace, Sunderland	(E)	Nov. 1884
Ord, Godfrey C., 72A, High Street, St. John's Ward, London, N....	(E E)	Jan. 1897
Orde, E. L., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Newcastle-upon-Tyne	(E)	Oct. 1887
Orlando, Chev. Giuseppe, Cantiere Navale, Fratelli Orlando, Leghorn	(N A)	Jan. 1893
Ormonde, John Grey, 35, Percy Gardens, Tynemouth	(E)	Nov. 1897
Orr, John, Prof., B.Sc., Kimberley Club, Kimberley, South Africa	(E)	Mar. 1897
Ortton, Alfred R., 27, General Graham Street, Chester Road, Sunderland	(E)	Nov. 1898
Ostens, Joseph, 4, Jackson Street, North Shields	(S)	Nov. 1900
Oxley, Alfred, 13, Beaconsfield Avenue, Low Fell, Gateshead ...	(C E)	Oct. 1902
Oxley, G., 51, Norman Terrace, Howdon-on-Tyne	(S)	Nov. 1884
Oxton, Walter, 5, Beech Lane, Stretton, near Burton-on-Trent	(E)	Graduate, Dec. 1890 Member, May 1894

P.

Page, F. J., Eng.-Lieut., R.N., 4, Alexandra Crescent, Newcastle-upon-Tyne	(E)	Dec. 1903
Parker, James H., 11, Gladstone Street, Hartlepool	(E)	April 1900
Parsons, The Hon. Charles A., M.A., F.R.S., Turbinia Works, Wallsend-on-Tyne	(E E)	Dec. 1887
Pascoe, J. R., Tyrmont, Woodford Green, Essex (*Life Member*) ...	(S)	Dec. 1889
Patterson, Jas., c/o Messrs. Caldwell & Co., Limited, Elliot Street, Glasgow	(E)	Nov. 1884
Patterson, Robert O., Thorneyholme House, Blaydon-on-Tyne	(E)	Graduate, Jan. 1895 Member, Dec, 1901
Patterson, Thomas Henry, 2, The Elms, Sunderland	(S)	Jan. 1902
Pattison, Jos., Bute Docks, Cardiff	(E)	Nov. 1884
Paulin, William J., 24, Oxford Street, Newcastle-upon-Tyne ...	(E)	April 1897
Paxton, John F., 52, Walker Terrace North, Gateshead	(E)	May, 1899
Pearson, James T., 26, Lish Avenue, Whitley Bay	(S)	Graduate, Nov. 1893 Member, Dec. 1897
Peat, Herbert, 9½, Russell Street, Stockton-on-Tees	(E)	Mar. 1902
Penney, R. H., Board of Trade Offices, 79, Mark Lane, London, E.C.	(S SUR)	Nov. 1884
Pepper, W., 9, West Villas, Oxbridge Lane, Stockton-on-Tees ...	(E)	Nov. 1888
Perrett, Jos. Richard, c/o Messrs. Sir W. S. Armstrong, Whitworth & Co., Elswick Shipyard, Newcastle-upon-Tyne	(N A)	Nov. 1896
Pescod, Joseph Hind, 1, Railway Street, Jarrow-on-Tyne	(S)	Graduate, Feb. 1898 Member, Jan. 1900
Petree, James, Lloyd's Register of Shipping, 12, Oriel Chambers, Water Street, Liverpool	(N A SUR)	Oct. 1885
Petterson, Carl Edwin, 7, Vestra Hamngaten, Gothenburg, Sweden	(E)	Oct. 1891
Phayer, Robert P., 27, Edwards Road, Whitley Bay, Northumberland	(S)	Dec. 1900

ELECTED.

Phillips, Joseph, 15, Park Avenue, Wallsend-on-Tyne ... ... (S) Dec. 1902
Philipson, Roland, Tynemouth... ... ... (E) Dec. 1884
Phorson, P., Glen Lea, Roker, Sunderland ... ... (S) Nov. 1884
Piaud, Leon, c/o Messrs. Delanney, Bellville, & Co., St. Denis, France ... ... (N A) Nov. 1888
Pierce, Robert Cecil, 14, West Park Gardens, Kew, Surrey ... ... (E E) { Graduate Dec. 1898 / Member Dec. 1899
Pill, Jos. H., Eng.-Com., R.N., 139, Park Road, Newcastle-upon-Tyne... ... ... (E) Nov. 1903
Pitt, Frederick William, 552, Chester Road, Old Trafford, Manchester, S.W. ... ... (E SUR) Oct. 1890
Poli, Rodolfo, Chioggia, Italy ... ... (N A) Jan. 1890
Pollock, Walter, c/o Messrs. Jas. Pollock, Sons, & Co., 3, Lloyds Avenue, London, E.C. ... ... (N A) April 1900
Posgate, James S., c/o Messrs. Montezuma Copper Co., Maeozari Senora, Mexico ... ... (E) { Graduate, Nov. 1895 / Member, Dec. 1901
Powell, James Richard, Royal Stuart Buildings, Cardiff ... ... (C E) May 1894
Pringle, Alfred, 10, Somerset Terrace, Walker-on-Tyne (S) { Graduate, Dec. 1891 / Member, Jan. 1894
Pringle, James G., 10, Somerset Terrace, Walker-on-Tyne .. ... (S) Oct. 1892
Proven, George, 358, Leith Walk, Leith, N.B. ... ... (E) Mar. 1901
Purdon, Andrew S., Messrs. Irvine's Shipbuilding and Dry Docks Co., Limited, West Hartlepool ... ... (S) Oct. 1892
Purvis, Andrew Alex., 17, Brook Terrace, Whitley Bay, Northumberland ... ... (E) Dec. 1899
Purvis, Fred. W., c/o Messrs. Sir W. Gray & Co., Central Shipyard, West Hartlepool ... ... (S) April 1893
Putnam, T., Darlington Forge, Darlington ... ... (FM) Nov. 1884

Q.

Quicke, Herbert John, c/o Messrs. Harfield & Co., Blaydon Ironworks, Blaydon-on-Tyne ... ... (E) Feb. 1891

R.

Ramage, J. T., St. Aubyn's, Bonnington, Edinburgh ... ... (E) April 1887
Ramage, John Anderson, 72, Glen Terrace, Hebburn-on-Tyne ... (S) Oct. 1892
Ranken, David, 8, Brookside Terrace, Sunderland ... ... (E) Nov. 1900
Rappaport, Fred. G., Messrs. Russian Petroleum and Liquid Fuel Co., Baku, South Russia ... ... (E) { Graduate, Mar. 1894 / Member, Jan. 1902
Readhead, Jas., Westoe Hall, South Shields ... ... (S) Nov. 1884
Readhead, John, Rockcliffe, Westoe, South Shields ... ... (E) Mar. 1886
Readhead, R., South Garth, Westoe Village, South Shields ... (E) Nov. 1884
Readhead, W. B., Beach View, South Shields ... ... (S) Nov. 1886
Redpath, David, 59, Claremont Road, Seaforth, Liverpool ... (E) Nov. 1901
Reed, Joseph, Angerton House, North Shields ... ... (E) Oct. 1889
Reed, J. W., c/o Messrs. Palmer's Shipbuilding and Iron Co., Limited, Engine Works Department, Jarrow-on-Tyne ... (E) Nov. 1884
Reid, John Robert, 8 Richmond Road, Ipswich ... ... (E) Nov. 1898
Reid, William, c/o Messrs. Wm. Reid & Co., 112, Fenchurch Street, London, E.C. ... ... (E) Dec. 1899

ELECTED.

Reilly, Myles O'Hara, 13, Woodlands Terrace, Borough Road, Middlesbrough ... ... (S) Oct. 1902
Rennoldson, C., Messrs. J. P. Rennoldson & Sons, South Shields (S) Jan. 1886
Rennoldson, Jos. M., Fairfield, Westoe, South Shields ... ... (S) Feb. 1886
Renton, James, Engineer's Department, Trinity House, Tower Hill, London, E.C.... ... ... (E) Jan. 1904
Reynolds, Charles H., c/o Messrs. Burmeister & Wain, Shipbuilders, Copenhagen, Denmark ... ... (S) Mar. 1889
Rhodes, Joseph Henry, Stonyroyd, Oxbridge Lane, Stockton-on-Tees ... ... (E) Nov. 1901
Richardson, Jas. Wm., Jesmond, Egerton Park, Rock Ferry, Cheshire ... ... (E & S) Nov. 1903
Richardson, John Lyth, Deddington Chambers, Hull ... ... (E) Nov. 1901
Richardson, Sir Thomas, B.A., Hartlepool Engine Works, Hartlepool ... ... (E) April 1888
Richardson, Wigham, Hindley Hall, Stocksfield, Northumberland (E & S) Nov. 1884
Rickaby, A. A., 27, Olive Street, Sunderland ... ... (E) Mar. 1888
Riley, J. H., Messrs. Riley Bros., Stockton-on-Tees ... ... (B B) May 1893
Riley, John, Granefield House, Oxbridge Lane, Stockton-on-Tees (B M) Oct. 1902
Riseley, Harry Lorimer, Western Villa, Wallsend-on-Tyne ... (E) Nov. 1900
Ritson, Maurice, Lloyd's Register of Shipping, Piazza S Giorgio, 32, Genoa ... ... (E SUR) Nov. 1884
Ritson, S. M., 2, Rectory Terrace, Sunderland ... (E) { Graduate, Nov. 1887 / Member, Nov. 1893
Roberts, W. C., 18, Windsor Road, Forest Gate, Essex ... ... (E) Mar. 1901
Robinson, Charles O., Ingleside, North Shields ... (E) { Graduate, Dec. 1893 / Member, Nov. 1899
Robinson, Francis, The Vicarage, Willington Quay-on-Tyne ... ... (E) { Graduate, Nov. 1897 / Member, Jan. 1902
Robinson, W., 10, Willow Avenue, Convent Lane, Anlaby Road, Hull ... ... (E) { Graduate, May 1895 / Member, April 1888
Robson, David M., 11, Village Terrace, South Shields... ... (E) Nov. 1899
Robson, George, 9, Wellington Terrace, South Shields ... ... (E) Oct. 1889
Robson, George, 155, Princess Street, Ipswich ... (E) { Graduate, Nov. 1901 / Member, Nov. 1903
Robson, John H., 22, Eversley Place, Heaton, Newcastle-upon-Tyne (E) Nov. 1885
Robson, John Hayes, 1, Claremont Terrace, South Shields ... (S) Feb. 1902
Robson, J. M., 4, Abbey Terrace, Gateshead-on-Tyne ... ... (E) Nov. 1884
Robson, M., 20, Tavistock Place, Sunderland ... ... (S) Nov. 1884
Robson, Nathaniel E., 5, Park Villas, The Green, Wallsend-on-Tyne ... ... (E) { Graduate, Dec. 1894 / Member, Nov. 1897
Robson, Robert, 5, St. Mary's Place, Newcastle-upon-Tyne (EE) { Graduate, Dec. 1894 / Member, Mar. 1901
Rodgerson, Wm. John, Engine Department, Carron Works, Falkirk, Stirlingshire ... ... (E) Nov. 1901
Roger, Robert, Stockton Iron Foundry, West Row, Stockton-on-Tees ... ... (E) Nov. 1888
Rogers, Herbert M., 81, Gracechurch Street, London, E.C. (SUR) April 1889
Rolf, George, 8, Bentinck Crescent, Newcastle-upon-Tyne ... (E E) May 1892
Rolland, Alexander, Villa Ruzic, Susak, Fiume, Hungary.. ... (E) Mar. 1892
Ropner, Robert, Jun., Hartburn, Stockton-on-Tees ... ... (S) Feb. 1886
Rosenthal, James H., Woodville, 97, Eltham Road, Lee, Kent ... (E) Dec. 1896

ELECTED.

Ross, Charles, c/o Messrs. Smith's Dock Co., Ltd., High Docks, South Shields ... ... (E) Jan. 1896
Ross, William, 20, Meadow Side, Dundee ... ... (E) May 1893
Routledge, Herbert J., Sandringham, Malone Road, Belfast ... ... (E E) Graduate, Mar. 1897; Member, Dec. 1901
Rowan, Jas., 231, Elliott Street, Glasgow ... ... (E) Nov. 1886
Rowell, G. W., 22, Armstrong Road, New Benwell, Newcastle-upon-Tyne ... ... (E) Feb. 1885
Rowell, H. B., Cleugh Brae, Jesmond East Park, Newcastle-upon-Tyne (*Life Member*) ... ... (S) Nov. 1884
Rusden, L., 14, Sanderson Road, Jesmond, Newcastle-upon-Tyne (E) Nov. 1884
Russell, F. Herbert, Scotia Engine Works, Sunderland ... ... (E) Oct. 1891
Rutherford, Robert T., 2, Lochaber Street, Routh Park, Cardiff ... (E) Nov. 1899
Ryder, C. L., Messrs. The London Salvage Association, Mount Stuart Square, Cardiff ... ... (E) Oct. 1886

S.

Sandeman, John Watt, 1, St. Nicholas' Buildings, Newcastle-upon-Tyne... ... ... (E) Oct. 1891
Sanders, H. W., 253, Rothbury Terrace, Heaton, Newcastle-upon-Tyne ... ... (S) Graduate, Nov. 1901; Member Nov. 1903
Sanderson, J., 31, Park Road, Jarrow-on-Tyne ... ... (S) Nov. 1884
Sawyer, John, c/o Messrs. Thos. Wilson, Sons, & Co., Hull ... (E) Oct. 1886
Scott, Ernest, Close Engine Works, Newcastle-upon-Tyne ... (E E) Nov. 1884
Scott, George, 36, Bede Burn Road, Jarrow-on-Tyne ... (S) Graduate, Jan. 1900; Member, May 1901
Scott, James, Selby Lodge, Consett, Co. Durham ... ... (E) Oct. 1892
Scott, Joseph, 49, Leazes Terrace, Newcastle-upon-Tyne (E) Graduate, Dec. 1891; Member, Oct. 1898
Scott, Joseph R., 9, Queen Street, Newcastle-upon-Tyne ... ... (E) Oct. 1887
Scott, Walter, 28, Hollybrook Road, Clontarf, Dublin ... ... (NA) Mar. 1897
Scott, William, c/o Messrs. R. & W. Hawthorn, Leslie & Co., St. Peter's, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Scott, William, Fern Dene, Lake Road West, Roath Park, Cardiff (E) June 1896
Seabury, Edward, Burnt Mill House, Harlow, Essex ... ... (E) Mar. 1886
Seaman, C. J., Newton Heath Iron Works, Manchester ... ... (E) Jan. 1889
Seaton, Albert Edward, Wilton House, Holderness Road, Hull ... (E) Jan. 1891
See, Horace, 1, Broadway, New York City, U.S.A.... ... ... (E) May 1896
Sergent, William John, 12, College Avenue, Crosby, near Liverpool ... ... (E) Oct. 1898
Shand, H., 31, Larkspur Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Sharp, A. E., c/o Messrs. The Peninsular and Oriental Steam Navigation Co., 122, Leadenhall Street, London, E.C. ... (E) Nov. 1884
Sharp, Mark, 144, Albert Road, Jarrow-on-Tyne ... ... (E) Dec. 1889
Shaw, Thomas, Messrs. Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (SUR) Nov. 1900
Sheret, William Robert, 15, Allworthy Avenue, Belfast .. .. (S) Nov. 1903
Sheriff, Thomas, c/o Messrs. Robert Mackill & Co., 53, Bothwell Street, Glasgow ... ... (E) April 1890
Short, John Gill, East Side, Tyne Dock, South Shields ... ... (NA) Feb. 1899
Short, Jos., 13, John Street, Sunderland ... ... (S) Nov. 1884

ELECTED.

Short, Thomas S., c/o Messrs. Short Brothers, Pallion, Sunderland ... ... (S) Graduate, Oct. 1892; Member, May 1899

Shute, A. E.. 12, Clyde View, Partick, Glasgow ... ... (E) Dec. 1892

Sibun, William, Lloyd's Register of Shipping, Bute Docks, Cardiff ... ... (SUR) Mar. 1896

Simpson, James, M., Eng.-Lieut., R.N., c/o The Admiralty, Whitehall, London, S.W. ... ... (E) Nov. 1901

Sinclair, Charles E., 18, James Street, Liverpool ... ... (C E) Jan. 1902

Sinclair, W. Rendall, 1 Stratford Villas, Heaton, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1901; Member, Dec. 1903

Singleton, Thomas, 46, Drury Buildings, Water Street, Liverpool (F) Apr. 1903

Sinton, John K., Bentham Buildings, 37, Side, Newcastle-upon-Tyne (E) Nov. 1885

Sisson, Wm., Gloucester ... ... (E & N A) Oct. 1888

Sivewright, G. W., 5, Radcliffe Terrace, Hartlepool ... ... (S) Nov. 1883

Skentelbery, Charles, c/o Messrs. Jacobs, Davies, and Barringer, 153, Mick Street, Boston, U.S.A. ... ... (E) Oct. 1900

Skentelbery, Joseph W., 7, Washington Terrace, North Shields ... (E) Dec. 1900

Skentlebury, G. Arthur, 22, Lansdowne Terrace, Gosforth. Newcastle-upon-Tyne ... ... (S) Oct. 1902

Skinner, Leslie, Westoe, South Shields ... ... (S) Graduate, Dec. 1886; Member, Oct. 1891

Smith, C. E., Cowesby, Clifton Avenue, West Hartlepool ... (E) Nov. 1888

Smith, Chas. R., 4, Belgrave Parade, Newcastle-upon-Tyne ... (E) Nov. 1903

Smith, E. J., Brandon House, Haughton-le-Skerne, Darlington ... (E) Dec. 1900

Smith, L. Eustace, Roseworth Cottage, Moor Road, Gosforth, Newcastle-upon-Tyne ... ... (E) Graduate, Oct. 1889; Member, Oct. 1892

Smith, Thomas, Steam Crane Works, Old Foundry, Rodley, near Leeds (E) Oct. 1888

Smith, Thomas Edward, Messrs. John Smith & Sons, Newgate Street, Newcastle-upon-Tyne ... ... (E) April 1885

Smith, Wm., 152, Roker Avenue, Sunderland, M. ... ... (E) Nov. 1884

Smith, Wm. Stawart, West Villa, The Green, Wallsend-on-Tyne ... ... (S) Graduate, Nov. 1893; Member, Dec. 1897

Sneddon, Alex. Russell, Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (E SUR) Nov. 1899

Snell, John F. C., M.I.C.E., Borough Electrical Engineer, Sunderland Corporation Electricity Department, Central Offices. Sunderland ... ... (E E) Mar. 1902

Soliani, Nabor, Col., Direttore del Cantiere Ansaldo, Sestri-Ponente, Italy ... ... (S) Jan. 1885

Spark, H. King, Messrs. The Anti-Attrition Metal Co., Ltd., Emerson Street, Southwark, London, S.E. ... ... (E) May 1898

Spence, W G., c/o Messrs. Swan, Hunter & Wigham Richardson, Ltd., Neptune Works, Walker-on-Tyne (*Life Member*) ... (E) Nov. 1884

Spencer, J. W., Newburn Steel Works, Newburn-on-Tyne ... (E) Feb. 1885

Squire, Charles E., 51, Shaftesbury Road, Ravenscourt Park, London, W. ... ...(E E) Graduate, Nov. 1893; Member, Oct. 1898

Staig, William Andrew, Station Road, Wallsend-on-Tyne ... (E) Feb. 1897

Stanley, John T., 6, Belmont Gardens, West Hartlepool ... ... (E) Oct. 1898

Stephen, A. E., Linthouse, Govan, Glasgow ... ... (E & S) June 1896

Stephen, John Murray, Linthouse Engine Works, Govan, Glasgow (E) Oct. 1895

Stephens, H. C. J., 94, Fortress Road, Kentish Town, London, N.W. ... ... (E) Graduate, Oct. 1890; Member, Nov. 1897

ELECTED.

Stephenson, Bernard, 42, Clincart Road, Mount Florida, Glasgow (E) Dec. 1896
Stephenson, C., 2, Elm Terrace, The Green, Wallsend-on-Tyne ... (S) Nov. 1884
Stevenson, Robert, Bentham Buildings, The Side, Newcastle-upon-Tyne ... ... (E) Oct. 1900
Stevenson, Wm., 1, Mosley Street, Newcastle-upon-Tyne... ... (E) Nov. 1884
Stewart, James, 13, Otterburn Terrace, Jesmond, Newcastle-upon-Tyne... ... ... (E) Oct. 1890
Stirling, Andrew, Jun., 1, Greenvale Terrace, Dumbarton... ... (E) Feb. 1888
Stirling, John F., Gilliat House, North Road, Darlington ... ... (F M) Oct. 1902
Stirzaker, J. C., 16, Grosvenor Place, Newcastle-upon-Tyne ... (E) Nov. 1884
Stoddart, A. Lane, York House, Pelaw-on-Tyne ... ... (S) Nov. 1898
Stoddart, J. E., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. .. .. (E SUR) Oct. 1888
Stoney, Gerald, c/o Messrs. C. A. Parsons & Co., Turbinia Works, Heaton, Newcastle-upon-Tyne ... ... (E) May 1902
Stuart, John, 135, Heaton Park Road, Newcastle-upon-Tyne (E) { Graduate, Dec. 1895 / Member, Nov. 1901
Stupersky, Antony, 1, North View, Wallsend-on-Tyne ... ... (S) May 1901
Summers, James, 4, Vicarage Terrace, Newtown, Stockton-on-Tees ... ... (E) Mar. 1889
Surtees, Charles, 42, Stansfield Street, Sunderland ... ... (S) Dec. 1900
Surtees, R., 12, Windsor Terrace, Whitley Bay ... ... (E) Nov. 1884
Swainston, William, 103, Cardigan Terrace, Heaton, Newcastle-upon-Tyne ... ... (FM) Nov. 1900
Swan, Charles Sheriton, c/o Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne ... ... (S) { Graduate, Nov. 1890 / Member, Mar. 1894
Swan, H. F., C.B., Col., Prudhoe Hall, Prudhoe-on-Tyne (*Life Member*) ... ... (S) Nov. 1884
Swinburne, M. W., The Cottage, Jesmond Park, Benton Road, Newcastle-upon-Tyne ... . (E) Nov. 1884
Swinburne, Matthew, 7, Frazer Terrace, Heworth, Felling-on-Tyne ... ... (S) { Graduate, May 1899 / Member, April 1901
Swinburne, T. M., 18, Bewick Road, Gateshead-on-Tyne ... ... (E) Jan. 1885
Swinney, W., 10, Wentworth Terrace, Westoe Lane, South Shields (E) Dec. 1888
Syme, James, Fairfield Works, Govan, Glasgow ... ... (E) Oct. 1892

T.

Tate, Chas. H., 7, Side, Newcastle-upon-Tyne ... ... (N A) Nov. 1884
Taylor, Alexander, Maritime Buildings, King Street, Newcastle-upon-Tyne . . .. (E) Nov. 1884
Taylor, J. T. Lloyd, Dock Engineer's Office, Middleton Road, West Hartlepool ... ... (CE) { Graduate, Oct. 1900 / Member, May 1903
Taylor, John, 1, St. Alban's Place, Tynemouth ... ... (E) Dec. 1894
Taylor, Martin B., 3, Park Villas, The Green, Wallsend-on-Tyne ... (S) Jan. 1902
Teasdale, John, 86, Mount Pleasant, Barrow-in-Furness ... ... (E) Mar. 1898
Terry, F. Herbert, Messrs. Tyne Brass and Copper Tube Manufacturing Co., Jarrow-on-Tyne ... ... (M) Feb. 1901
Thackrah, John, 6, Claremont Avenue, Woodhouse Square, Leeds (E) Nov. 1901
Thew, Charlton, 80, Osborne Road, Newcastle-on-Tyne (E) { Graduate, Dec. 1899 / Member, Nov. 1902
Thomas, Benjamin, 8, Balmoral Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Feb. 1899

		ELECTED.
Thomas, Harold, 43, University Street, Belfast	(S)	Apr. 1903
Thomas, William, 4, Eton Avenue, Hampstead, London, N.W.	(E)	Graduate, Oct. 1895 Member, Nov. 1899
Thompson, Arthur E., 10, Gowan Villas, Jesmond, Newcastle-upon-Tyne	(E)	May 1898
Thompson, C. E., Thornbeck, Thornhill Park, Sunderland ...	(S)	Nov. 1884
Thompson, Jas., 2, Carlton Terrace, Sunderland	(E)	Dec. 1886
Thompson, Joseph Andrew, North Sands Shipyard, Sunderland ...	(S)	Nov. 1901
Thompson, Robert Norman, North Sands Shipyard, Sunderland ...	(S)	Nov. 1901
Thompson, Robert, Over Dinsdale Hall, Darlington	(S)	Nov. 1884
Thorman, T., 40, King's Road, Leytonstone, Essex	(E)	Mar. 1901
Thomson, James, M.A., 22, Wentworth Place, Newcastle-upon-Tyne	(E & N A)	Nov. 1890
Thorn, W. H., 5, Waterville Terrace, North Shields	(E)	Nov. 1884
Thornton, James M., 9, Queen's Square, Bristol	(E)	April 1893
Thyne, John Sinclair, 32, Azalea Terrace N., Sunderland	(S)	Dec. 1899
Tinn, Frei. D., North View, Mowbray Road, South Shields ...	(S)	Nov. 1891
Tinn, George, 205, Cardigan Terrace, Gateshead-on-Tyne	(E)	Dec. 1897
Tocher, J. W., c/o Messrs. Wallsend Slipway and Engineering Co., Wallsend-on-Tyne	(S)	Mar. 1898
Todd, George William, 53, Victoria Road, Hebburn-on-Tyne	(S)	Graduate, Jan. 1898 Member, Dec. 1899
Todd, John P., 21, Stephen Street, Edge Lane, Stretford, near Manchester	(E)	Dec. 1897
Todd, William Surtees, Coronation Buildings, Quayside, Newcastle-upon-Tyne	(N A)	Nov. 1901
Toomer, C. R., Ravensworth, Westoe, South Shields	(E)	Jan. 1899
Toovey, Alfred F., 28, Burdon Terrace, Newcastle-upon-Tyne ...	(E)	Dec. 1894
Tose, Thomas, 171, Earlam Grove, Forest Gate, Essex	(E)	Mar. 1901
Towers, Edward, Jun., 27, Brandling Park, Newcastle-upon-Tyne	(E)	Graduate, Nov. 1886 Member, Oct. 1888
Trail, John, 21, Grosvenor Place, Jesmond, Newcastle-upon-Tyne	(M S)	Oct. 1892
Traill, Robert, 6, Windsor Crescent, Whitley Bay, Northumberland	(E)	Oct. 1896
Trechmann, J. E., Norton Lodge, Stockton-on-Tees	(E)	Feb. 1898
Trewent, F. J., 43, Billiter Buildings, Billiter Street, London, E.C.	(S)	Dec. 1884
Tsimenis, Andrew, 12, Roxburgh Place, Heaton, Newcastle-upon-Tyne	(N A)	Graduate, Oct. 1900 Member, Jan. 1902
Turnbull, John, 103, Warton Terrace, Heaton, Newcastle-upon-Tyne	(E)	Nov. 1898
Turner, Charles N., 21, Lansdowne Terrace, Gosforth, Newcastle-upon-Tyne	(E)	Graduate, April 1896 Member, Dec. 1901
Turner S. J., 71, Warwick Street, Heaton, Newcastle-upon-Tyne	(E)	Mar. 1887
Turpie, David Whyte, c/o Messrs. W. Pickersgill & Sons, Southwick, Sunderland	(S)	Dec. 1895
Tuxen, Holger, Bureau Veritas Register of Shipping, Heibersgade, 14, Copenhagen, K.	(S)	Nov. 1896
Twaddell, James L., Green Bank, Jarrow-on-Tyne	(S)	Oct. 1891
Tweedy, G. F., 1, Grosvenor Villas, Jesmond, Newcastle-upon-Tyne	(E)	May 1899
Tweedy, John, Kelso House, Fernwood Road, Jesmond, Newcastle-upon-Tyne	(E)	Nov. 1884

U.

ELECTED.

Ulm, John, The Arsenal, Pola, Austria ... ... (E) Nov. 1885
Urquhart, Douglas M., 13, Gill Side Grove, Roker, Sunderland ... (S) May 1899

V.

Vardy, George, c/o Messrs. Swan. Hunter & Wigham Richardson, Ltd., Neptune Works, Newcastle-upon-Tyne (E) { Graduate, Oct. 1894 / Member. 1898
Varty. Bartholomew Snowball, c/o Laurie, 14, Great George Street, Hillhead, Glasgow ... ... (S) { Graduate Oct. 1895 / Member May 1901
Vianson, N. S., *viâ* Corsica 20/5, Genoa, Italy ... ... (E) Dec. 1885
Vick, R. W., Messrs. Furness, Withy & Co., Middleton Shipyard, West Hartlepool ... ... (S) Nov. 1888
Vowell. Josias, S.S. "Bida," c/o Messrs. Elder, Dempster & Co., Luineshof Newgroingerstrasse 1, Hamburg ... ... (E) Feb. 1901

W.

Wadagaki, Yasuzo, Navy Department, Tokio, Japan ... ... (E) Jan. 1891
Waddingham, William H., 5, Claremont Terrace, Newcastle-upon-Tyne ... ... (E) { Graduate, Nov. 1897 / Member, Dec. 1902
Wailes, William C., 23, Richmond Road, Cardiff ... (E) { Graduate, Nov. 1898 / Member, Nov. 1901
Wait, Thomas Herbert, Cail's Buildings, Quayside, Newcastle-upon-Tyne ... ... (C E) Dec. 1893
Wake, Tom, 14, Bellesley Terrace, West Hartlepool ... ... (E) April 1892
Walker, Archibald, 143, Leith Walk, Leith, N.B. ... ... (E) April 1887
Walker, Henry, 9, Gladstone Terrace, Gateshead-on-Tyne ... (E E) Feb. 1893
Walker, James, c/o Messrs. River Tyne Commissioners' Office, Bewick Street, Newcastle-upon-Tyne ... ... (C E) Nov. 1898
Walker, John, c/o Messrs. R. Stephenson & Co., Limited, South Street, Newcastle-upon-Tyne ... ... (E & S) Nov. 1891
Walker, Sept. H., ... (E) Nov. 1899
Wallace, John, 14, Havelock Street, Newcastle-upon-Tyne ... (E) Nov. 1903
Wallau, J., 16, Woodhouse Terrace, Gateshead-on-Tyne ... ... (E) Nov. 1884
Waller, Thomas Naunton, Rushmere, Wylam-on-Tyne ... ... (E) May 1898
Wallis, Robert, Wh.Sc., Point Pleasant House, Wallsend-on-Tyne (E) April 1891
Walter, Max, Norddeutscher Lloyd, Central Bureau, Bremen ... (S) Feb. 1893
Walton, J. G., 26, Fenchurch Street, London, E.C. ... ... (E) Nov. 1884
Walton, Samuel, 5, Tyne View Terrace, South Shields ... ... (E) Dec. 1893
Warburton, J., Greenlands, Cleadon, near Sunderland ... ... (S) Nov. 1884
Warburton, John Arthur. 13, Grindon Terrace, Sunderland (E) { Graduate, Mar. 1894 / Member, Nov. 1896
Ward, Herbert John, The Mill House, Farningham, Kent ... (SUR) Nov. 1898
Ward, John, c/o Messrs. W. Denny & Bros., Dumbarton ... ... (S) Dec. 1891
Wardale, Henry, 9, Woodhouse Terrace. Gateshead-on-Tyne ... (E) Feb. 1888
Watson, John, 62, Wandsworth Road, Heaton, Newcastle-upon Tyne ... ... (S) { Graduate. Dec. 1897 / Member. Dec. 1901
Watson, Michael, 4, St. Nicholas Buildings, Newcastle-upon-Tyne (C E) Oct. 1900
Watson, Thomas Henry, 112, Sidney Grove, Newcastle-upon-Tyne (SUR) Jan. 1896
Watt, Alex. Jas, 15. Croft Terrace, Jarrow-on-Tyne .. ... (E) Nov. 1903

ELECTED.

Watts, Philip, Col., F.R.S., LL.D., The Admiralty, London ... (S) Nov. 1885
Wawn, Tom Noel, c/o Messrs. Lloyd's Register of Shipping, Dock Chambers, Barry, South Wales ... ... (SUR) Jan. 1900
Webster, William Milne, 22, Lesbury Road, Heaton, Newcastle-upon-Tyne ... ... (E) Nov. 1900
Weidemann, Nils, Det-Norske Veritas, Christiania, Norway ...(SUR) Jan. 1892
Weighton, R. L., M.A., 2, Park Villas, Gosforth, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Weir, George Dobie, Sunderland Engine Works, South Docks, Sunderland ... ... (E) Oct. 1894
Weir, John, 46, Lawrence Street, Partick, Glasgow ... ... (E) Nov. 1884
Weir, William, 190, Nithsdale Road, Pollokshields, Glasgow ... (E) Nov. 1889
Weiss, T. L., Marine Engineer, 17, Sandhill, Newcastle-upon-Tyne (E) Nov. 1903
Welton, J. G.. 138, Cleveland Road, Sunderland .. .. (E) Nov. 1893
West, Henry H., British and Foreign Chambers, 5, Castle Street, Liverpool ... ... (E & N A) Oct. 1886
Westgarth, Tom, Messrs. Richardsons, Westgarth & Co., Middlesbrough ... ... (E) Oct. 1886
Westmacott, Alfred, Clairvaux, Nettlestone, Isle of Wight ... ... (E) { Graduate, Dec. 1885 / Member, Nov. 1892
Westmacott, P. G. B., Rose Mount, Sunninghill, Berks ... ... (E) Nov. 1884
White, A. F., c/o Messrs. Nippon Yusen Kaisha, 2, Fenchurch Avenue, London, E.C. ... ... (E) Feb. 1901
White, C., 13, Mosley Street, Newcastle-upon-Tyne ... ... (E) Nov. 1884
White, R. Saxon, Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Walker-on-Tyne ... ... (S) Nov. 1884
Whitfield, Ernest, 11, Victoria Terrace, Low Fell, Gateshead-on-Tyne... ... ... (E) Dec. 1899
Whyte, James Anderson, 196, Watt Street, Glasgow ... ... (E) May 1902
Whyte, Wm., Eastrigg, Corbridge-on-Tyne ... ... (E) Nov. 1884
Widdas, T. D., 56, Plasturton Avenue, Cardiff ... ... (SUR) April 1885
Widdowfield. John H., 3, Beaconsfield Terrace, Gateshead-on-Tyne ... ... (E) Nov. 1901
Wight, Henry D., 7, Holmlands Park, Sunderland ... ... (E E) Dec. 1898
Wildridge, Richard, c/o R. W. Brachead, Bury Street, N. Sydney, N.S.W. ... ... (E) { Graduate, Oct. 1895 / Member, Oct. 1898
Wilkinson, Thomas, 9, Laburnum Avenue, Wallsend-on-Tyne ... (S) Nov. 1899
Willcox, F. A., B.Sc., 18, Holinlands, Park, Sunderland ... ... (C E) Nov. 1903
Willcox, Henry Walker, 15, Norfolk Street, Sunderland ... ...(C E) Nov. 1897
Willcox, Percy F. C., 15, Norfolk Street, Sunderland ... ...(C E) Nov. 1897
Willcox, R. J. N., c/o Messrs. Fleming & Ferguson, Ltd. Shipbuilders and Engineers, Paisley ... (E) { Graduate, Mar. 1892 / Member, Dec. 1897
Williams, Thomas, Messrs. South Durham Steel & Iron Co., West Hartlepool ... ... (I & S M) Dec. 1900
Williams, Thomas R., "Holmeside," 142, Bede Burn Road, Jarrow-on-Tyne ... ... (S) Oct. 1895
Williamson, Robt. Tate, 105, Talbot Road, Old Trafford, Manchester (E) Oct. 1900
Wilson, B.Sc., Alfred Carruthers, 97, Park Road, Wallsend-on-Tyne (E) Nov. 1901
Wilson, Edmund, 8, Oakfield Terrace, Forest Hall, near Newcastle-upon-Tyne ... ... (E) Nov. 1901
Wilson, Henry J. H., "Lancefield," Kellfield Avenue, Low Fell, Gateshead-on-Tyne ... ... (E) Nov. 1895

ELECTED.

Wilson, Henry Maxson, 7, Akenside Terrace, Newcastle-upon-Tyne (E) May 1902
Wilson, James, Messrs. Richardsons, Westgarth & Co., Hartlepool Engine Works, Hartlepool ... ... (E) Jan. 1896
Wilson, John Paul, 123, Osborne Road, Jesmond, Newcastle-on-Tyne (S) Oct. 1895
Wilson, John Reginald, Lyndhurst, Gosforth, Newcastle-upon-Tyne ... ... (E E) Graduate, Mar. 1894; Member, Dec. 1899
Wimble, Arthur, 10, Ventnor Gardens, Monkseaton ... ... (E) Dec. 1893
Winstanley, P. D., Bureau Veritas Register of Shipping, 155, Fenchurch Street, London ... ... (S) Nov. 1884
Withy, H., Middleton Shipyard, West Hartlepool ... ... (S) Nov. 1884
Wood, Henry Alfred, Oakland, North Ormesby, Middlesbrough-on-Tees ... ... (S) Dec. 1893
Wood, John Scott, 4, Sanderson Road, Newcastle-upon-Tyne ... ... (S) Graduate, Oct. 1891; Member, Oct. 1896
Wood, Lionel, 4, Simonside Terrace, Heaton, Newcastle-upon-Tyne ... ... (E E) Graduate, Nov. 1897; Member, Jan. 1903
Wood, William, 6, Eslington Terrace, Newcastle-upon-Tyne ... (S) Nov. 1897
Woodeson, Wm. A., 13, Richmond Terrace, Gateshead-on-Tyne ... (E) Nov. 1901
Wortley, Henry B., Kent House, Egerton Park, Rock Ferry, Birkenhead... ... ... (S) Graduate, Jan. 1886; Member, Nov. 1892
Wotherspoon, James Douglas, 39, Hainton Street, Grimsby ... (E) April 1900
Wray, Thomas W., Board of Trade Offices, Sunderland ... ...(SUR) Jan. 1895
Wright, George H., 23, Albury Park Road, Tynemouth (EE) Graduate, Feb. 1896; Member, Dec. 1901
Wright, R., 5, Hawthorn Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Wurl, Max, 44, Burdon Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1903
Wynd, William Adam, 8, Dilston Terrace, Gosforth, Newcastle-upon-Tyne ... ... (N A) Feb. 1902
Wyse, Thomas, North Lodge, Walker-on-Tyne ... ... (E) Nov. 1898

Y.

Young, Andrew, Bureau Veritas, Register of Shipping, 155, Fenchurch Street, London, E.C. ... ... (S) Graduate, Feb. 1892; Member, May 1893
Young, J. Denholm, 6, Commercial Court, 17, Water Street, Liverpool ... ... (E) Oct. 1888
Younger, R. Elmire House, Heaton, Newcastle-upon-Tyne ... (E) Nov. 1884

Z.

Zeeman, J. H., 82, Celebesstraat, is Gravenhage ... ... (S) Oct. 1889

ASSOCIATES.

A.

Allan, Alex. Selkirk, 16, Denwick Terrace, Tynemouth ... ... (M) Dec. 1903
Anderson, Daniel G., c/o Messrs. W. Angus & Co., Grainger Street West, Newcastle-upon-Tyne ... ... (A) Nov. 1893
Armstrong, S., Victoria Road, West Hartlepool ... ... (A) Nov. 1888
Armstrong, Thomas Henry, c/o Messrs. British Uralite Co., 50 Cannon Street, London, E.C. ... ... (E A) Nov. 1900

B.

		ELECTED.
Barklam, George, Braemar, Dudley Port, Staffordshire	(A)	April 1888
Barr, John Smith, 16, Broad Chare, Quayside, Newcastle-upon-Tyne...	(A)	Nov. 1893
Barnes, Henry, 43, Otto Terrace West, Sunderland	(A)	Nov. 1901
Barwick, J. S., Ashbrook Grange, Sunderland	(S O)	Nov. 1884
Beynon, Thomas, Hamburg Chambers, Quayside, Newcastle-upon-Tyne	(E A)	Oct. 1891
Bigge, C. W., Northern Counties Club, Newcastle-upon-Tyne ...	(A)	Dec. 1889
Bingham, Sir J. E., Bart., West Lea, Ranmoor, Sheffield	(M)	Mar. 1895
Bird, William, 22, Percy Gardens, Tynemouth	(A)	May 1896
Borrie, Walter, Messrs. Blair & Co., Ltd., Stockton-on-Tees ...	(A)	Jan. 1899
Bowmer, John J., 8, Tankerville Terrace, Newcastle-upon-Tyne...	(S O)	Nov. 1901
Brims, D. N., 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ...	(C)	Nov. 1893
Brown, Charles Ernest, 1, Ashleigh Villas, East Boldon, near Sunderland	(A)	Oct. 1900
Brown, Percy Ledger, 1, St. Nicholas' Buildings, Newcastle-upon-Tyne	(E A)	Oct. 1896
Brunton, John, 3, Prior's Terrace, Tynemouth	(S O)	Oct. 1886
Bullen, Tempest C., c/o Messrs. H. E. Moss & Co., K. Exchange Buildings, Newcastle-upon-Tyne	(S O)	Nov. 1891

C.

Carr, Ralph, Thornleigh, Clayton Road, Newcastle-upon-Tyne	(A & S O)	Nov. 1886
Caws, Frank, 22, Fawcett Street, Sunderland	(C E)	Oct. 1892
Cay, Arthur, Messrs. Cay, Hall & Co., 10, St. Vincent's Parade, Bristol	(S O)	Nov. 1884
Cohan, Edward Asher, 2, Rumford Place, Liverpool	(S O)	Nov. 1889
Cory, John, Mount Stuart House, Cardiff	(S O)	June 1896
Coull, John, Baltic Chambers, Quayside, Newcastle-upon-Tyne ...	(S O)	Oct. 1886
Crawford, Thomas, 10, Haldane Terrace, West Jesmond, Newcastle-upon-Tyne	(A)	Oct. 1896
Crosier, Edward James, 3, The Hawthorns, East Boldon	(A)	Oct. 1889
Culliford, J. H. W., 45, West Sunniside, Sunderland	(S O)	Nov. 1884

D.

Dixon, Thomas, c/o Messrs. Sir Raylton Dixon & Co., Ltd., Shipbuilders, Middlesbrough	(A)	May 1902
Dodds, E. F., 36, Side, Newcastle-upon-Tyne	(A)	Nov. 1893
Dodds, John B., 36, Side, Newcastle-upon-Tyne	(CHEM)	Oct 1888
Donkin, Geo., Jun., 50, Grove Street, Newcastle-upon-Tyne ...	(A)	April 1897
Dove, Edward John, 5, St. Nicholas' Buildings, Newcastle-upon-Tyne	(M)	Oct. 1890
Douglas, John, c/o Messrs. Walker & Hall, 60, Grey Street, Newcastle-upon-Tyne	(A)	Oct. 1898

E.

Eccles, Edward, Royal Insurance Buildings, Queen Street, Newcastle-upon-Tyne (*Life Associate*)	(S O)	Oct. 1887
Elder, George H., Cail's Buildings, Quayside, Newcastle-upon-Tyne	(S O)	Feb. 1903
Evans, Fred. George, 10, Neville Street, Newcastle-upon-Tyne ...	(A)	Nov. 1901
Evans, T. L., Capt., 59, Broad Street, Bristol	(S S)	Jan. 1904

F.

		ELECTED.
Fellows, Alfred, Bergholt House, Park Road, Jarrow-on-Tyne	(I & S M)	Nov. 1901
France, James A., 74, Lauderdale Mansions, Maida Vale, W. ...	(M)	Jan. 1898
Furness, Sir Christopher, Baltic Chambers, West Hartlepool ..	(S O)	Oct. 1888
Forster, George, 8, Warwick Street, Heaton, Newcastle-upon-Tyne		Oct. 1898

G.

Gaunt, Richard, The Laurels, New Park Road, Stockton-on-Tees	(A)	Oct. 1902
Geary, William, 6, Chaloner Terrace W., South Shields	(M S)	May 1899
Gore, Thomas Hoskins, 52, Queen's Square, Bristol	(S O)	April 1902
Graham, Frank, 21, Groat Market, Newcastle-upon-Tyne ...	(E A)	Nov. 1891

H.

Hardy, John, Jun., Victoria Road, West Hartlepool	(I M)	Nov. 1893
Harland, George, 1, Westoe Crescent, South Shields	(A)	Dec. 1888
Harris, John T., c/o Messrs. Irvine's Shipbuilding Co., Ltd., West Hartlepool	(A)	Mar. 1902
Harrison, Samuel Turner, The Green, Wallsend	(A)	Nov. 1897
Harrison, Thomas, 9, Bridge Street, Sunderland	(A)	Dec. 1894
Hedley, John H., Elms West, Sunderland	(S)	Dec. 1886
Hedley, Robert, 3, Summerhill Grove, Newcastle-upon-Tyne ...	(A)	Nov. 1899
Henderson, John T., 5, Logan Terrace, South Shields	(M)	May 1900
Henzell, Chas. Wright, D, Exchange Buildings, Lombard Street, Newcastle-upon-Tyne	(A)	Nov. 1901
Henzell, Robert, Northern Oil Works, Newcastle-upon-Tyne (*Life Associate*)	(M)	Nov. 1893
Heslop, Richard O., M.A., Akenside Hill, Newcastle-upon-Tyne	(I & S M)	Oct. 1885
Hinchliffe, John, Stoneleigh, Monkseaton, Northumberland ...	(A)	Nov. 1899
Hodges, Thomas Wm., 86, Osborne Road, Newcastle-upon-Tyne	(A)	Nov. 1899
Hogg, John Thomas, Tyneside Brass Works, Barry Docks, South Wales	(I & S M)	April 1896
Holliday, Henry, Beechgrove, Blackhill, Co. Durham	(A)	Nov. 1895
Hollis, John, c/o Messrs. John Brown & Co., Ltd., 144, St. Vincent Street, Glasgow	(S M)	May 1901
Holzapfel, Max, Maritime Buildings, Quayside, Newcastle-upon-Tyne	(M)	May 1900
Hudson, Ralph M., Jun., Tavistock House, Borough Road, Sunderland...	(S O)	Dec. 1886
Hudson, Robert, 24, Hotspur Street, Tynemouth	(A)	Nov. 1895
Hunting, Charles S., 1, Exchange Buildings, Quayside, Newcastle-upon-Tyne	(S O)	April 1886

I.

Innes, Charles H., M.A., Rutherford College, Newcastle-upon-Tyne	(E)	Oct. 1891

J.

Jennings. Albert Edward, 4, The Crescent, Gateshead-on-Tyne ...	(M)	Nov. 1901
Jobson, W. J., 10, Holly Avenue, Jesmond, Newcastle-upon-Tyne	(A)	May 1889
Jordan, John George, 6, Cedars Crescent, Ryhope Road, Sunderland	(A)	Nov. 1892

K.

ELECTED.

King, Ernest, Messrs. Mellowes & Co., Corporation Street, Sheffield ... ... (A) April 1903

L.

Levin, Otto, Maritime Buildings, King Street, Newcastle-upon-Tyne ... ... (A) Nov. 1902
Lodwidge, Philip, Baltic Chambers, Sunderland ... ... (A) June 1896
Lord, W. R., 41, Queen's Road, Jesmond, Newcastle-upon-Tyne ...(M M) Feb. 1900
Lucock, George, 45, Lansdowne Terrace, Horsley Hill Road, South Shields ... ... (M) Oct. 1900

M.

Macarthy, George E., 54, Pilgrim Street, Newcastle-upon-Tyne ...(S O) Oct. 1887
Mail, Douglas B., 3, St. George's Terrace, Jesmond, Newcastle-upon-Tyne ... ...(M S) Feb. 1895
Maughan, William, 13, Mosley Street, Newcastle-upon-Tyne ... (A) Feb. 1887
MacIntyre, John, 3, Abbotsford Terrace, Newcastle-upon-Tyne... (S O) Jan. 1885
McBeath, Harry C., c/o Messrs. John Spencer & Sons, Newburn Steel Works, Newburn ... ... (A) Dec. 1900
Meek, John George, 13, Belle Vue Park, Sunderland ... ... (A) Dec. 1894
Milburn, J. D., Queen Street, Newcastle-upon-Tyne ... ...(S O) Nov. 1884
Miller, T. R., 9, Great St. Helen's, London, E.C. ... ... (A & S O) Nov. 1884
Mitcalfe, John Stanley, Chairman of Northern Maritime Insurance Co., Maritime Buildings, Newcastle-upon-Tyne ... (A & S O) Jan. 1892
Moss, J. Frank, Jr., 48, Clifford Road, Sharow, Sheffield ... ... (S M) Nov. 1901
Muller, J. C. F., 79, Rue Harringrode, Antwerp ... ...(SUR) Feb. 1890
Murray, Henry H., Hastings Lodge, Hartlepool ... ... (A) Dec. 1901
Murray, Matthew, The Green, Wallsend-on-Tyne ... ... (A) Nov. 1893

N.

Naismith, John, Neptune Works, Newcastle-upon-Tyne ... ... (A) Nov. 1901
Nielsen, Hans Christian, 12, Cliff Terrace, Hartlepool ... . (S O) Feb. 1898

O.

Olsen, Hans Benedick, 70, Church Street, West Hartlepool ... (S O) Mar. 1893

P.

Park, Robert, Lauriston, Blackhill, Co. Durham . ... (A) Dec. 1897
Parker, George, 62, John Street, Sunderland ... ... (A) Dec. 1899
Patterson, Thos., 2, The Elms, Sunderland ... ... (S) Jan. 1885
Petersen, William, Messrs. Petersen & Tate, Bank Chambers, Sandhill, Newcastle-upon-Tyne... ... ... (S O) Nov. 1893
Pilditch, Alfred, Grange Villa, Jarrow-on-Tyne ... ... (A) Nov. 1903
Pinkney, Thomas, 3, Ashbrook Terrace, Sunderland ... ...(S O) Dec. 1886
Potts, Turnbull, Commercial Buildings, Tyne Docks, South Shields (SUR) Nov. 1898
Pringle, George Frederick, 29, Grainger Street West, Newcastle-upon-Tyne ... ...(E A) May 1901
Proctor, J. H., 22, Hawthorn Terrace, Newcastle-upon-Tyne ... (I M) Nov. 1893

R.

ELECTED.

Raine, John, Baltic Chambers, Sunderland ... ... (S O) Nov. 1897
Ramsay, J. W., 13, Northbrook Road, Lee, Kent ... ... (A) Feb. 1885
Ramsay, Norman F., 20, Sanderson Road, Newcastle ... ... (B F) Jan. 1902
Reichwald, A., Finsbury Pavement House, Finsbury Pavement, London, E.C. ... ... (A) Nov. 1884
Reid, Sidney, Printer, Akenside Hill, Newcastle-upon-Tyne ... Nov. 1884
Renwick, G., M.P., Messrs. Fisher, Renwick & Co., Colllingwood Buildings, Newcastle-upon-Tyne ... ... (S O) Nov. 1884
Rimer, William Thomas, Craigielea, Low Fell, Gateshead-on-Tyne (M) Nov. 1900
Ritson, Arthur, 30, West Sunniside, Sunderland ... ... (S O) Feb. 1899
Robson, John William, Mercantile Chambers, Quayside, Newcastle-upon-Tyne ... ... (M) April 1896
Rogers, Thomas W., 284, Beverley Road, Hull ... ... (A) May 1901

S.

Scholefield, A., 17, Sandhill, Newcastle-upon-Tyne ... ... (S O) Nov. 1884
Sisson, W. E., 9, Northumberland Terrace, Tynemouth ... ... (A) Nov. 1899
Snowdon, W. F., 32, Side, Newcastle-upon-Tyne ... ... (E A) Dec. 1886
Stallybrass, William S., 30, Dean Street, Newcastle-upon-Tyne ... (M) Mar. 1901
Stephenson, George R., c/o Messrs. N. E. Marine Engineering Co., Northumberland Engine Works, Wallsend ... ... (A) Nov. 1899
Storey, Christopher, 13, Sunbury Avenue, Jesmond, Newcastle-upon-Tyne ... ... (A) April 1896
Sutherland, Arthur M., Eastcliffe, Elmfield Road, Gosforth, Newcastle-upon-Tyne ... ... (S O) Nov. 1897
Swinney, Robt. Nesbit, Messrs. Swinney Bros., Ltd., Morpeth, Northumberland ... ... (A) Nov. 1901

T.

Taylor, Edward, Tyneside Works, Scotswood-on-Tyne ... ... (M) Mar. 1902
Taylor, Swainson T., Tyneside Works, Scotswood-on-Tyne ... (M) Mar. 1902
Temple, George T., 20, Beach Avenue, Whitley Bay, Northumberland ... ... (A) Jan. 1899
Temple, John, Baltic Chambers, Newcastle-upon-Tyne ... (S U R) Mar. 1901
Thompson, V. T., Baltic Chambers, Sunderland ... ... (S O) Dec. 1886
Thompson, Wm. H., 5, Albany Gardens, Whitley Bay, Northumberland .. .. (A) Nov. 1899
Thorpe, Samuel, Market Place, Chambers 74, High Street, Sheffield ... ... (I & S M) Feb. 1901
Todd, John Stanley, Maritime Buildings, Newcastle-upon-Tyne (U) Nov. 1895
Tomkins, Harry, 3, Lorne Terrace, Stockton-on-Tees ... (CONTR) Oct. 1902
Towers, Edward, 27, Brandling Park, Newcastle-upon-Tyne ... (A) Oct. 1888
Towers, Michael G., Clementhorpe, North Shields ... ... (A A) Dec. 1899
Trechmann, Otto K., Church Street, West Hartlepool ... ... (S O) Oct. 1896
Tully, Robert, 9, The Lawe, South Shields ... ... (M S) May 1900
Turner, Edwin, 32, Powell Road, Clapton, London, N.E. ... ... (A) Oct. 1895

W.

ELECTED.

Wainford, Edgar H., 3, Woodbine Road, Gosforth, Newcastle-upon-Tyne ... ... (A) Nov. 1899
Wallace, H. S. (*Life Associate*) ... ... (S) May 1899
Ward, Heber, Messrs. Walker & Hall, Sheffield ... ... (A) Feb. 1901
Wardle, James, 7, Osborne Te race, Gosforth, Newcastle-upon-Tyne... ... ... (M) Nov. 1901
Walton, John Jos., Lloyd's Represent., Lindisferne Holly Avenue, Whitley Bay ... ... Nov. 1903
Watson, Thomas W., Gisburn House, Hartlepool ... ... (M S) Nov. 1890
Weatheral, Henry, 27, Alderson Street, West Hartlepool ... ... (A) Feb. 1893
Weller, William, 7, Lovaine Terrace, North Shields ... ... (S O) Dec. 1899
Wilkie, John William, Prince's Buildings, Quayside, Newcastle-upon-Tyne ... ... (S O) Oct. 1900
Willis, Thomas W., 93, Clifton Avenue, West Hartlepool ... ... (S O) Nov. 1899
Wilson, F. Alfred, 45, West Sunniside, Sunderland ... ... (I M) Nov. 1893
Wilson, James, 61, Falmouth Road, Heaton, Newcastle-upon-Tyne (A) Nov. 1901
Winstanley, Robt. Hope, 25, Westmoreland Road, Newcastle-upon-Tyne... ... ... (A) Nov. 1897

Y.

Yeoman, F., Ship and Steamship Broker, West Hartlepool ... (S O) Nov. 1888
Young, J. A., St. Ann's Rope Works, Newcastle-upon-Tyne ... (R M) May 1901
Young, John Barrow, Optician, 46, Dean Street, Newcastle-upon-Tyne ... ... Nov. 1901
Younger, Robert Laurie, Messrs. Greenock Steamship Co., Limited, Greenock ... ... (A) Feb. 1889

GRADUATES.

A.

Allan, Percy F., c/o Messrs. Kennedy & Jenkin, 17 Victoria Street, Westminster, London, S.W. ... ... (E) Nov. 1901
Allen, John C., 20, Mayfair Road, West Jesmond, Newcastle-upon-Tyne... ... ... (E) Dec. 1899
Anderson, Thomas C., Bigges Main House, Wallsend-on-Tyne ... (E) Mar. 1902
Andrew, John Davis, 33, Osborne Road, Newcastle-upon-Tyne ... (E) Jan. 1898
Atkinson, Harry, 137, Park Road, Newcastle-upon-Tyne ... ... (E) Nov. 1901

B.

Backhouse, A. E., Hurworth Grange, Croft, Darlington ... ... (EE) Mar. 1903
Bailey, Ralph U., 3, South Avenue, Ryton-on-Tyne ... .. (E) Dec. 1901
Bainbridge, Thos. Lindsay, Holmwood, Newcastle-upon-Tyne ... (S) Dec. 1903
Batty, George L., 42, Rye Hill, Newcastle-upon-Tyne ... ... (EE) Mar. 1903
Bennett, George H., c/o Mrs. Wilson, 21, Woodbine Street, Gateshead-upon-Tyne ... ... (S) Dec. 1900
Berriman, A. E., 128, Fordwych Road West, Hampstead, London, N.W. ... ... (E E) Feb. 1900

ELECTED.

Blake, Leonard James, 20, Laburnum Avenue, Wallsend-upon-Tyne (E) Dec. 1903
Bolton, Frank, Beaconsfield Square, Hartlepool ... ... (S) May 1903
Bowmer, Matthew N., 8, Tankerville Terrace, Jesmond, Newcastle-upon-Tyne ... ... (E) Dec. 1900
Brown, George M., 21, Westmoreland Road, Newcastle-upon-Tyne (EE) Mar. 1903
Bullen, Harold, 15, Caroline Street, Jarrow-on-Tyne ... ... (E) Dec. 1902
Burnup, E. Cyril, 2, Wentworth Place, Newcastle-upon-Tyne ... (EE) Mar. 1903
Burr, Percy B., 16, St. George's Terrace, Newcastle-upon-Tyne ... (E) Dec. 1900

C.

Collin, Albert H., 23, Castle Street, Leicester ... ... (E) Dec. 1902
Cooper, Wm. L., Park House, Jarrow-on-Tyne ... ... (E) Nov. 1903
Cothay, Frank H., 38, The Avenue, Sunderland ... . (E) Feb. 1901
Coull, Thomson Bankhead, South Preston, North Shields... ... (E) Dec. 1902
Cox, Harry Jasper, 21, Victoria Square, Newcastle-upon-Tyne ... (S) Dec. 1903
Crawford, T. W., 10, Haldane Terrace, Newcastle-upon-Tyne ... (E) Nov. 1903
Crow, William George, Holme Lea, Darlington ... ... (E) Nov. 1900
Cruickshank, Andrew, Gurie House, Park Road, Hebburn-on-Tyne (E) Nov. 1899
Currie, Hugh B., 48, Jesmond Road, Newcastle-upon-Tyne ... (E) Nov. 1897
Curry, Albert, 68, Ryehill, Newcastle-upon-Tyne ... ... (E) Nov. 1901
Cuttle, Henry H., 156, Eastbourne Avenue, Gateshead-on-Tyne ... (E) Jan. 1902

D.

Darby, Harold, 1, Ladbroke Terrace, London, W. ... . (E) Jan. 1903
Davies, Thomas, 42, Rye Hill, Newcastle-upon-Tyne ... ... (E E) Mar. 1903
Davison, Joseph P., 107, Clumber Street, Newcastle-upon-Tyne ... (S) Oct. 1898
Denton, G. P., 63, Osborne Road, Newcastle-upon-Tyne ... ... (S) Jan. 1903
Dickinson, Thomas, 105, High Park Road, Newcastle-upon-Tyne (E) Nov. 1901
Dilworth-Harrison, D. R., 17, Granville Street, Gateshead-on-Tyne ... ... (E E) Nov. 1899
Dowsen, Junr., Charles, 21, Croft Terrace, Jarrow-on-Tyne ... (S) Feb. 1901
Driver, John Wm., 21, Grosvenor Place, North Shields ... ... (E) Feb. 1904
Durrant, Aubrey Percy ... ... (E) Nov. 1901
Dyke, F. S., Dene Lodge, Walker-on-Tyne ... ... (E) Nov. 1903

E.

Edminston, Alex. R., Ivy Cottage, Highfield Road, Walton, near Liverpool ... ... (E) Jan. 1898

F.

Finlay, George, 27, Clayton Park Square, Newcastle-upon-Tyne... (E) Nov. 1902
Fortune, Thomas C., 76, Falmouth Road, Heaton, Newcastle-upon-Tyne... ... ... (E) Jan. 1902

G.

Gibbs, Alfred Percy, 83, Goldhurst Terrace, South Hampstead, London, N.W. ... ... (E) Nov. 1901
Glahome, John W., 43, North Terrace, Wallsend-on-Tyne... ... (E) Nov. 1899

ELECTED.

Grey, Robert Bertram, 15, Victoria Villas, W., Newcastle-upon-Tyne (E) Oct. 1900
Green, Fred. Wm., 20, Salisbury Gardens, Newcastle-upon-Tyne (E) Jan. 1902
Grey, Alfred Wm., Maidstone Gas Co., Maidstone ... ... (E) Nov. 1901

H.

Hall, George, 7, Wellington Terrace, South Shields ... ... (E E) Mar. 1903
Heck, John S., 10, Bristol Terrace, Newcastle-upon-Tyne ... ... (E) Dec. 1899
Heck, William D., 10, Bristol Terrace, Newcastle-upon-Tyne ... (E) Jan. 1902
Hedley, Ralph, Jun., 19, Belle Grove Terrace, Newcastle-upon-Tyne (E E) Dec. 1899
Henderson, Joseph Nevison, 60, Woodbine Street, Gateshead-upon-Tyne ... ... (E) Dec. 1903
Hermon-Hodge, Harry Baldwin, 19, Prudhoe Terrace, Tynemouth (S) Dec. 1903
Hobson, J. W., Iris Cottage, Edward Gardens, South Benwell, Newcastle-upon-Tyne ... ... (E) Nov. 1903
Hogarth, Horace, 95, Wingrove Avenne, Newcastle-upon-Tyne ... (E E) April 1904
Holmes, Stephen, 15, Park Road, Jarrow-on-Tyne ... ... (S) Dec. 1901

J.

James, Chas A., 39, Beverley Terrace, Cullercoats ... ... (S) Nov. 1903
James, Matthew C., Jun., 54, Hartington Street, Barrow-in-Furness ... ... (E E) May 1899
James, Wm. E., 39, Beverley Terrace, Cullercoats ... ... (S) May 1899
Jennings, Edward C., 4, The Crescent, Gateshead-on-Tyne ... (E) Nov. 1901
Johnston, Jas. McFetridge, 97, Duncairn Gardens, Antrim Road, Belfast ... ... (S) Nov. 1903
Jones, Edward, 26, Rye Hill, Newcastle-on-Tyne ... ... (E E) Mar. 1903

K.

Kirk, Malcolm, 91, Wharncliffe Street, Newcastle-upon-Tyne ... (E E) Mar. 1903
Knight, Robt. C., Elswick Shipyard Newcastle-upon-Tyne ... (S) Nov. 1901

L.

Lamb, Robert, 165, Park Road, Newcastle-upon-Tyne ... ... (E) Apr. 1903
Leitch, George A., Netherlea, Newport-on-Tay, Scotland ... ... (E) Jan. 1902
Leitch, John Shearer, 114, Heaton Road, Heaton, Newcastle-upon-Tyne ... ... (S) Mar. 1903
Little, Alvin, 39, Leazes Terrace, Newcastle-upon-Tyne ... ... (E) Mar. 1901
Little, John, High Street, Felling-on-Tyne ... ... (E) Feb. 1903
Lovatt, John James, 15, Kingsley Place, Heaton, Newcastle-upon-Tyne ... ... (E) Jan. 1903
Lowrison, Wm. R., Drawing Office, Elswick Shipyard, Newcastle-upon-Tyne .. .. (S) Nov. 1901
Luhrs, H., c/o Mr. L. J. Blake, 20 Laburnum Avenue, Wallsend-on-Tyne ... ... (E) Nov. 1899

M.

Mackley, John Robert, 97, Enfield Road, Elswick, Newcastle-upon-Tyne ... ... (E) Dec. 1902
Matheson, Ian Ross, The Clack, Hebburn-on-Tyne ... ... (S) Dec. 1902
Matthews, John Wm., 28, Mainsforth Terrace West, Sunderland (S) Feb. 1904

ELECTED.

McRae, Alexander, 60, Chillingham Road, N., Heaton, Newcastle-upon-Tyne ... ... (S) Mar. 1903
McWilliams, Edwin J., 95, Wingrove Avenue, Newcastle-upon-Tyne (E E) Mar. 1903
Milne, George Murray, 18, Kirton Park Terrace, Preston Road, North Shields ... ... (S) Feb. 1898
Moore, Edward George, 32, De Grey Street, Elswick, Newcastle-upon-Tyne ... ... (E) Apr. 1904
Mowll, Harold, The Green, Wallsend-on-Tyne ... ... (E) Nov. 1903

N.

Neill, John, 15, Salem Hill South, Sunderland ... ... (E) Nov. 1901
Nichol, Robert, c/o Messrs. Thwaites Bros., Vulcan Ironworks, Bradford ... ... (E) Feb. 1902
Nichols, George Henry, 30, Denmark Street, Gateshead-on-Tyne (E) Oct. 1900

O.

Ogilvie, William, 28, Ivy Road, Gosforth, Newcastle-upon-Tyne ... ... (E E) Oct. 1902

P.

Phillips, Alexander, 15, Park Avenue, Wallsend-on-Tyne... ... (S) Dec. 1902
Pinder, John c/o Messrs. Adamez, Limited, Sanitary Engineers, Scotswood-on-Tyne ... ... (E) Mar. 1904
Pringle, R. A., 138, Tynemouth Road, Heaton, Newcastle-upon-Tyne (E E) Nov. 1901

R.

Readhead, Stanley, Westoe Hall, South Shields ... ... (S) Dec. 1902
Read, Robt., 57, Warrington Road, Newcastle-upon-Tyne ... (E) Nov. 1903
Richardson, Norman Shephard, Eng. Sub-Lieut., R.N., Mosscroft, Gateshead-on-Tyne ... ... (E) Mar. 1901
Robertson, R. A., Thanai Tea Estate, Dikona, Debroghar, Assam, British India ... ... (E) Nov. 1903
Robson, Geo., Jun., 9, Wellington Terrace, South Shields ... ... (E) Mar. 1899

S.

Samson, Robert D., 10, St. Thomas Crescent, Newcastle-upon-Tyne (E) Feb. 1902
Schaeffer, Paul P., 4, Woodbine Avenue, Gosforth, Newcastle-upon-Tyne ... ... (E) Feb. 1902
Slee, Herbert Teal, 37, Grosvenor Place, Newcastle-upon-Tyne ... (E) Jan. 1903
Smith, John E., 15, Eslington Terrace, Newcastle-upon-Tyne ... (E) Nov. 1897
Spittle, Henry Stuart, 20, Eskdale Terrace, Newcastle-upon-Tyne (E) Oct. 1900
Stagg, Albert E. ... ... (E) Nov. 1899
Stanger-Leathes, C. Francis, 192, Heaton Road, Heaton, Newcastle-upon-Tyne ... ... (S) Dec. 1903
Stirzaker, Stanley C., 16, Grosvenor Place, Newcastle-upon-Tyne (E) Nov. 1901

T.

	ELECTED
Talbot-Palmer, Edward, 231, Albert Road, Jarrow-on-Tyne ...	(E) Feb. 1904
Tait, Robert, 192, Heaton Road, Heaton, Newcastle-upon-Tyne ...	(S) Dec. 1903
Taylor, John Allibon, 1, St. Alban's Place, Tynemouth	(E) Feb. 1904
Tchighianoff, Alec., 45, Lovaine Place, Newcastle-upon-Tyne ...	(E) Nov. 1903
Thomas, Robt. C., 21, Wentworth Place, Newcastle-upon-Tyne ...	(M E) Nov. 1903
Thompson, John, 43, Mayfair Road, West Jesmond, Newcastle-upon-Tyne	(E E) Mar. 1903
Thornton, E. Fielding, ...	(E) Dec. 1900
Tulip, Wilfred, Whinney Hill, Choppington, Morpeth, Northumberland	(E) Mar. 1902

V.

Vick, Henry Hampton	(S) Jan. 1903

W.

Wardroper, Arthur K., Walker Vicarage, Walker-on-Tyne ...	(E) Dec. 1901
Watson, Arthur William, 29, Front Street, Tynemouth	(S) Dec. 1903
Watson, John G. B., 5, Nesham Street, Newcastle-on-Tyne ...	(S) Jan. 1902
Watson, Kenneth, 3, Rosella Place, North Shields	(E) Mar. 1899
Waymouth, Norman, 54, Tavistock Road, Jesmond, Newcastle-upon-Tyne	(E) Nov. 1901
Webb, Edmund, Whitby House, Cardigan Terrace, Gateshead ...	(E) Nov. 1903
Webster, Peter, 22, Lesbury Road, Heaton, Newcastle-upon-Tyne	(S) Dec. 1903
Whiting, W. R. G.	(S) Nov. 1903
Wilson, James Dare, Rose Cottage, Shotley Bridge, Co. Durham	(E E) Mar. 1903
Wilson, James J. Vernon, 62, Alexandra Road, Upper Norwood, London	(E) Nov. 1903
Wilson, William, "Lancefield," Kellfield Avenue, Low Fell, Gateshead-on-Tyne	(E) Feb. 1902
Winstanley, P. G., 11, Hartington Street, Barrow-in-Furness ...	(S) Oct. 1898

THE NORTH-EAST COAST INSTITUTION

OF

ENGINEERS AND SHIPBUILDERS.

Constitution and Bye-Laws,

ADOPTED AT A GENERAL MEETING ON THE 4TH MARCH, 1885.

REVISED AT THE CLOSING BUSINESS MEETING HELD ON 4TH MAY, 1887.

RE-REVISED AT THE CLOSING BUSINESS MEETINGS HELD ON 9TH MAY, 1888, 13TH MAY, 1889, 11TH MAY, 1891, 14TH MAY, 1895, 13TH MAY, 1898, 22ND MAY, 1903, AND MAY 18TH, 1904.

CONSTITUTION.

I.—The NAME of the Association is "The North-East Coast Institution of Engineers and Shipbuilders." Name.

II.—The OBJECTS for which the Institution is established are:—The advancement of the science and practice of Engineering and Shipbuilding, and the interchange of ideas and information amongst its members, by means of meetings for the reading and discussion of papers relating thereto, and placing on record its transactions. Objects.

III.—The Institution shall consist of Honorary Members, Members, Associates, and Graduates.

IV.—HONORARY MEMBERS shall be such distinguished persons as the Council may elect. Honorary Members.

V.—MEMBERS shall be Principals or Principal Managers engaged in Engineering or Shipbuilding; Civil, Military, or Mining Engineers, or Naval Architects; whose subscription shall be Two Guineas per annum: and other persons engaged in the above professions; whose subscription shall be One Guinea per annum. Members.

VI.—ASSOCIATES shall be such persons as are not strictly Engineers or Shipbuilders, but are connected with or interested in such pursuits, and are deemed by the Council to be eligible for Associate membership. Their subscription shall be One Guinea per annum. Associates.

VII.—GRADUATES may be persons under twenty-four years of age, engaged in study or employment to qualify themselves for any of the above professions. Their subscription shall be Half-a-Guinea per annum.

VIII.—Any MEMBER may become a LIFE MEMBER by a single payment of Twenty Guineas, or any ASSOCIATE may become a LIFE ASSOCIATE by a single payment of Ten Guineas. All such compositions shall be deemed to be capital moneys of the Institution.

IX.—The COUNCIL of the Institution shall be elected from and by the Members, and shall consist of one President, the Past-Presidents, eighteen Vice-Presidents, fifteen Ordinary Members of Council, and an Honorary Treasurer.

X.—The President and Honorary Treasurer shall be elected annually. Three Vice-Presidents and five Ordinary Members of Council shall be elected annually. The retiring Vice-Presidents shall be those who have been in office for the longest period, and Ordinary Members of Council those who have served three years from their last election.

The President shall be eligible for re-election for a second year; should he be re-elected he shall retire at the conclusion of his second year of office, and shall not again be eligible until after an interval of one year.

The retiring Vice-Presidents shall be eligible for re-election. The retiring Ordinary Members of Council shall not be eligible for re-election to the same office until after an interval of one year, but shall be eligible for election to any other office.

The Honorary Treasurer shall be eligible for re-election annually, or for election to any other office.

XI.—Honorary Members may attend all the General Meetings, they may read papers, take part in discussions, in voting, in moving and supporting resolutions, in presentation of notices of motion, or in requisitions for Special Meetings, and in the proposition of new members; they shall also receive copies of the Transactions.

XII.—Members shall have all the privileges of the Institution as enumerated in the foregoing paragraph, and shall be eligible for office.

XIII.—Associates shall have all the privileges enumerated in paragrapn XI. They shall be eligible for office as Ordinary Members of Council

XIV.—Graduates may attend all the General Meetings, they may read papers, take part in discussions, and support resolutions; they shall also receive copies of the Transactions, but shall not sign proposals for new members, vote, nor be eligible for office. Graduates' Privileges.

XV.—The General Meetings of the Institution shall be held during the months of October to May, inclusive, of each year. General Meetings.

NOTE.—When the word Member is initialled with a capital letter it signifies a member under paragraphs IV. and V., but when initialled with a small letter, it signifies a member of any class of the Institution membership.

BYE-LAWS.

MEMBERSHIP.

1.—Every candidate for admission as a Member, Associate, or Graduate shall be proposed and recommended according to the Form A in the Appendix, in which form the name, usual residence or the place of business, the qualification for, and proposed class of membership of the candidate shall be distinctly specified. Proposals for Graduates must give the date of, and age, last birthday. Candidates for Admission.

The form shall be signed by a Member or Associate of the Institution, as proposer, and by at least other three Members or Associates as supporters, certifying a personal knowledge of the candidate.

The proposal so made shall be submitted to the Council, when, if it be approved, the Chairman shall sign the approbation, which shall be inserted in the notice calling the next General Meeting, when the candidate shall be balloted for, and shall be accepted if three-fourths of the votes are favourable.

2.—Graduates desirous of becoming Members shall be proposed and recommended according to the Form B in the Appendix. Graduates becoming Members

The proposal so made shall be submitted to the Council, who shall agree to or reject it.

3.—The balloting for membership shall be conducted in the following manner:—Each member shall be supplied by post with a list of the names of the candidates, according to the Form C in the Appendix, and shall strike out the names of such candidates as he desires shall not be elected. These lists may be Balloting for Members.

returned to the Secretary by post, or may be deposited in the ballot-box by the voter in person on entering a meeting at which an election is to take place. The ballot-box will be closed at ten minutes after the advertised time of meeting. The lists shall then be handed over to the Chairman, who shall appoint two Scrutineers to examine them, after which examination the Chairman shall inform the meeting of the result.

Candidates to receive Notice of Election.

4.—Notice of Election as a member shall be sent to the candidate within one week after his election, according to the Form D in the Appendix; but his name shall not be added to the list of Members, Associates, or Graduates of the Institution, until he shall have paid his first annual subscription.

Rejection of Candidates.

5.—In case of rejection of the candidate, no mention thereof shall be made in the minutes, nor shall any notice be given to the unsuccessful candidate.

Subscriptions payable in Advance.

6.—All subscriptions shall be payable in advance, and shall become due on the 1st of August each year. Any Member, Associate, or Graduate, wishing to retire from the Institution shall continue to be liable for his annual subscription until he shall have given formal notice of his retirement to the Secretary, which notice must be given on or before the 31st of August in each year. Application for membership may be made at any time during a Session, and the subscription shall cover the membership up to the 1st of August following.

Receipt of Subscription.

7.—On payment of each subscription the Secretary shall forward to the member an official receipt.

Questions of Privilege.

8.—On question of privilege.—Any person who may be unknown in the meeting shall only be able to claim the privilege in question on proving his membership for the current Session.

Arrears of Subscriptions.

9.—Any member whose subscription is one year in arrear shall be reported to the Council, who shall direct application to be made for it, according to Form E in the Appendix; and in the event of its continuing in arrear until the end of that Session after such application, the Council shall have the power, after remonstrance by letter, according to the Form F in the Appendix of declaring that the defaulter has ceased to be a member.

Power of Council to remove Name from List of members.

10.—The Council may refuse to continue to receive the subscriptions of any member who shall have wittingly acted in contravention of the Regulations of the Institution, or who shall,

in the opinion of the Council, have been guilty of such conduct as shall have rendered him unfit to continue his membership; and the Council may remove his name from the list of members: and such person shall thereupon cease to be a member of the Institution. Notice of such action of the Council shall be forwarded to the person in question, in accordance with the Form G in the Appendix. The reason for such action of the Council shall not be stated to the person expelled, without the sanction of the Council.

OFFICERS.

Election of Officers.

11.—The Annual Election of Officers shall be conducted in the following manner:—The Council shall meet in March or April, and shall arrange a list of nominations, in accordance with the Form H in the Appendix. It shall nominate new names in the place of the retiring Members, and the number of nominations shall be one in excess of the number required in each section of the Council. Such list shall be presented at the General Meeting immediately preceding the last General Meeting of the Session, and any Member present shall be at liberty to nominate additional Members. The list shall show who remain in office throughout the Council, and who are retiring. A copy of this ballot list shall be forwarded to each Member and Associate, together with a complete list of Members of Council, to be filled in, in accordance with the instructions printed in the ballot form, and to be returned to the Secretary to be opened in the presence of the Council, at a Council Meeting which shall be held in April or May, when the scrutiny and counting shall be carried out by the Council. Any Member in voting shall be at liberty to erase any name or names from the list and substitute the names of any other person or persons eligible for each respective office other than those already placed on the ballot list by the Council and Members of the Institution.

Any voting paper returning either more or less than one President, eighteen Vice-Presidents, one Honorary Treasurer, and fifteen Ordinary Members of Council, shall be disqualified for the section or sections in which such errors occur, and the votes shall be lost for the said section or sections. The votes given as President, to a Member who is not elected President, shall count to him as a Vice-President; the votes given as Vice-President, or Treasurer, to persons not so elected, shall count to

them as Ordinary Members of Council, unless they have just completed a term of office in such capacity.

The voting list shall not be sent to any Member and Associate whose subscriptions are more than one year in arrear; nor shall any such Member be nominated on the list. For this purpose, the Secretary shall prepare, previously to the meeting of Council, a list of those Members whose subscriptions are more than one year in arrears.

lot to be lared at May ting.

12.—The result of the ballot for Officers shall be declared at the Closing Business Meeting, to be held in May, at which meeting general business shall be transacted. The newly-elected Officers shall enter into office on the 1st day of August following; and the new President shall be installed at the Annual General Meeting in October.

ver of Council ll up Casual ancy.

13.—The Council shall have power to supply any casual vacancy within itself (including any casual vacancy in the office of President), which shall occur between one May Meeting and another; and the Officers so appointed shall retire when the persons whose places they fill would have retired. Vacancies not filled during the year shall be filled at the General Election.

GENERAL MEETINGS.

ieral etings.

14.—The Annual General Meeting shall take place in October, and the Closing Business Meeting in May; each of these meetings shall be held in Newcastle-upon-Tyne. The Ordinary Meetings shall take place in the second week in each following month during the Session, unless otherwise arranged by the Council, and at such hours and places as the Council may determine.

tice of etings.

15.—Seven clear days' notice of every General Meeting, Ordinary or Special, specifying the nature of business to be transacted, shall be given to every member of the Institution.

cial General etings.

16.—A Special General Meeting may be convened at any time by the Council, and such meeting shall be convened by the Council whenever such is the declared wish of a General Meeting, or whenever a written requisition, signed by twenty members, specifying the object of the meeting, is left with the Secretary. If, for fourteen days after the delivery of such requisition, a meeting be not convened in accordance therewith, the requisitionists, or any twenty members of the Institution, may convene a Special Meeting in accordance with the requisition. The business discussed at such Special Meetings shall only be that indicated on the notice calling the meeting.

Quorum.

17.—Twenty Members shall constitute a quorum for the purpose of a meeting other than a Special Meeting. Thirty Members shall constitute a quorum for the purpose of a Special Meeting.

Chairman at Meetings.

18.—The President shall be chairman at every meeting, and in his absence, one of the Past-Presidents or one of the Vice-Presidents; or in the absence of these, an Ordinary Member of Council shall take the chair; or if no Member of Council be present and willing to take the chair, the meeting shall elect a Chairman.

Decisions of General Meetings.

19.—The decision of a General Meeting shall be ascertained by a show of hands; or, when five Members or Associates shall demand, or the Chairman may think it desirable, the decision shall be taken by ballot. The manner of counting the votes shall be at the discretion of the Chairman, and an entry in the minutes, signed by the Chairman, shall be deemed sufficient evidence of the decision of a General Meeting. In cases of equality of votes, the Chairman shall have a casting vote; otherwise he shall not vote.

Questions of a Personal Nature in General Meetings.

20.—Questions of a personal nature arising in a General Meeting, shall, if possible, be referred to the Council, otherwise the decision of the meeting shall be taken by ballot on a motion or amendment put to the meeting. The ballot shall be taken by the voters (being Members or Associates) writing "for" and "against" on a slip of paper. The slips shall be folded and collected, and then counted in the presence of the meeting, and the result announced by the Chairman. Should fewer than twenty votes be given, it shall be understood that the question is shelved, and the votes shall be destroyed without being opened.

Transactions of Business, General Meetings.

21.—At every General Meeting of the Institution, the Secretary shall first read the minutes of the preceding meeting, which, on approval, shall be signed by the Chairman; business arising out of these minutes shall then be transacted. The Secretary shall read any notices which may have to be brought before the meeting. Notices of motion may then be given, and other business of the Institution may be attended to; but when a paper is to be read, the foregoing business shall not be extended beyond half-an-hour after the advertised time for commencing the meeting. The paper or papers for the evening shall then be read and discussed.

Dissolving General Meeting

22.—If within half-an-hour after the time fixed for holding a General Meeting a quorum is not present, the meeting shall be

dissolved, and all matters which might, if a quorum had been present, have been done at the meeting so dissolved, may forthwith be done on behalf of the meeting, by the Council; except the reading or discussion of a paper, which shall not proceed in the absence of a quorum.

Adjourning a General Meeting.

23.—Any General Meeting of the Institution may be adjourned by a vote of the Members and Associates present if there be a quorum; if there be not a quorum, the case shall be met by the preceding paragraph.

Introduction of Friends.

24.—Each member shall have the privilege of introducing one friend to the General Meetings, whose name must be written in the Visitors' Book, together with that of the member introducing him; but if the introducing member be unable to attend the meeting, he may send the name of the visitor to the Secretary. During such portions of any of these meetings as may be devoted to any business connected with the management of the Institution, visitors may be requested by the Chairman to withdraw. This shall be done if five Members or Associates, or both, present request it.

COUNCIL MEETINGS.

Council Meetings.

25.—The Council shall meet before each General Meeting, or on other occasions when the President shall deem it necessary; being summoned in either case by circular, stating the time of meeting, and the business, so far as is known.

Convening Meeting for Expenditure of Funds.

No business involving expenditure of the funds of the Institution (except by way of payment of current accounts) shall be transacted at any Council Meeting, unless the circular gives six clear days' notice, and states the business.

Discussions of Personal Character

All discussions of a personal character in the Council shall be considered and treated as being strictly confidential.

Regulation of Proceedings.

26.—The Council may regulate its own procedure, and delegate any of its powers and discretions to any one or more of its number.

Chairman and Quorum.

The President shall, *ex officio*, be chairman of all Council Meetings, and in his absence one of the Past-Presidents or one of the Vice-Presidents shall take the chair; or in the absence of these, one of the Ordinary Members of Council shall be elected to take the chair. Five members of Council, including the Chairman, shall form a quorum.

Sub-Committees.

In the appointment of Sub-Committees, the Council shall determine the number which shall form a quorum in each case,

and shall appoint a Chairman. These regulations shall not affect the Finance Committee.

Sub-Committees.

27.—The Council may appoint Committees either from itself, or with the assistance of persons outside, for the purpose of transacting any special business, or of investigating specific objects connected with the work and interests of the Institution.

Sub-Committees.

28.—All Committees or Sub-Committees shall be appointed by the Council, and shall be subject to that body, and shall report to it. The Council shall act upon these reports or recommendations as it may think best. The President shall, *ex officio*, be a member of all Committees.

Communication to Council.

29.—Any member may by communication addressed to the Secretary petition the Council to lay before a General Meeting of the Institution the contents of any letter which shall in a short, concise, and clear manner draw the attention of the Institution to public matters of importance in connection with legislation proposed by any governing body in reference to the construction of ships, machinery, or the working of the same, so that members may by their scientific and practical knowledge demonstrate the soundness or otherwise of the proposed measure.

Invitation to Strangers.

30.—The Council may invite to General Meetings or to Council Meetings any person or persons whose presence and assistance it may desire, and strangers so invited shall be permitted to take part in the proceedings, but not to vote.

Secretary and Treasurer's Duties.

31.—The Secretary, who shall also act as Treasurer, shall be appointed by and act under the direction and control of the Council, and shall be paid such salary as the Council shall determine. He shall attend all meetings, Council and General, and shall take minutes of the proceedings, and enter them in proper books provided for the purpose. He shall write the correspondence of the Institution and Council, read minutes and notices at meetings, report discussions, and, if required by the Council, prepare papers for reading and publication, and read papers and communications at the meetings. He shall receive all payments due to the Institution, and shall bank the cash in hand whenever it amounts to ten pounds. The bank shall be determined by the Council and the banking account shall be in the names indicated in connection with the Finance Committee. He shall keep a cash account book, general and detail, which shall on all occasions be open to inspection by the Finance

Committee or by the Council. He shall keep a register of the names of members, so arranged as to distinguish all members whose subscriptions are in arrear. He shall also perform whatever other duties are indicated in the Bye-Laws of the Institution as appertaining to his department; and shall remain in office during the pleasure of the Council. He shall not vote on any resolution.

32.—The following Sub-Committees shall be appointed annually at the first meeting of the Council in each Session:—

Finance Committee.

(1) A Finance Committee, to consist of seven persons, viz.: one Past-President or Vice-President, who shall be Chairman; five Members of Council, and the Honorary Treasurer of the Institution; three of whom shall form a quorum. The Treasurer shall be empowered to pay all amounts due from the Institution which are under two pounds. All amounts of two pounds and upwards shall be paid by cheque, signed by the Chairman of the Finance Committee (or in his absence, by the President or a Past-President), the Secretary and the Honorary Treasurer.

Payment of Accounts.

Reading and Library Committees.

(2) A Reading Committee, to consist of six members of Council. No member who has served on this Committee for three years in succession shall be eligible for re-election until after an interval of one year. (3) A Library Committee, in accordance with Library Rules, Nos. 1 and 3. (4) A Graduates' Award Committee to consist of five members.

TRANSACTIONS.

Papers to be submitted to Council.

33.—All papers shall be forwarded to the Secretary at least five clear weeks before the proposed date of reading. The Secretary shall submit them for approval to the Council, and on their general approval they shall be handed to the Reading Sub-Committee, three of whom at least, shall read the paper through.

Reading Sub-Committee.

The Reading Sub-Committee shall be at liberty to strike out any parts which, in their opinion, ought not to be read. They may also make any suggestions to the author as to points which might with advantage be inserted or altered.

Synopsis of Papers.

A synopsis of the subject-matter of each paper shall be forwarded to the Secretary, by the writer, for insertion in the circular convening the meeting at which the paper is to be read.

Printing Transactions

34.—The papers read, and the discussions on them, or such portions of them as the Council shall select, shall be printed for

distribution among the members, each of whom shall receive a copy. These Transactions shall be edited by the Secretary, in accordance with instructions of the Council, who shall have power to omit parts of discussion which may be foreign to the subject, or which it may be deemed undesirable to retain. Each paper shall bear the date on which it was read in General Meeting.

Copy of Papers supplied to members before reading, etc.

35.—Copies of papers to be read during any Session will be sent seven days before the date of reading to members who shall have applied to the Secretary for them, in writing, at the commencement of the Session. The discussion on a paper shall not be considered closed on the evening on which it is read, but shall be open for renewal at a subsequent meeting, prior to the reading of the paper set down for that date.

Proofs sent to members for Correction.

36.—The Secretary shall send to each speaker as soon as possible after a General Meeting a copy in manuscript of the speaker's own remarks for correction. This copy must be returned to the Secretary within four days. A printed proof will also be sent to each speaker for further revision; this must be returned to the Secretary within three days, otherwise it will be deemed correct, and printed off after receiving verbal corrections.

Liberty to Print Explanatory Notes.

37.—The Council shall be at liberty to print as Transactions, either with the papers and discussions or separately, explanatory notes, etc., communicated after the reading or discussing of a paper. Such communications must be approved by the Reading Committee, and shall bear the date on which they shall have been received by the Secretary.

Institution not responsible for statements.

38.—The Institution shall not be held responsible for the statements and opinions advanced in any of the papers which may be read, or in the discussions which may take place at the Meetings of the Institution.

Copies of Transactions to be sent to members.

39.—Twenty copies of each paper and discussion shall be presented to the author of the paper, for private use, and one copy shall be sent to each member. When a paper is prepared by two authors, fifteen copies shall be presented to each. Duplicate copies of parts of the Transactions mislaid or lost by members cannot be supplied to them, except as provided for in Bye-Law 42.

Transactions not supplied to members in Arrears.

40.—The Transactions shall not be supplied free to members whose subscriptions are unpaid.

Members not to receive Transactions till after First Payment.

41.—Any member elected at any time between the Annual General Meetings shall be entitled to copies of all the Transactions issued during the Session to which his first subscription applies; but not until the subscription has been paid.

Transactions the Property of the Institution.

42.—The Transactions of the Institution shall be the exclusive property of the Institution, and shall be published only by the authority of the Council. Additional copies of papers required by authors for their private use can only be procured from the Secretary, at prices fixed by the Council from time to time, and these copies must contain the whole of the discussion following the papers, and be bound in the usual cover, with the addition of the following words:—"By permission of the Council," and "Excerpt Minutes of Proceedings." Duplicate volumes and copies of parts of the Transactions, if in print, can also be obtained from the Secretary, and shall be sold only by him, in such manner and at such prices as the Council shall have fixed.

Rule of Discussion.

43.—During a discussion upon any paper, no person shall be at liberty to speak more than once (except by way of explanation), nor for a longer period than ten minutes.

ACCOUNTS, &c.

Accounts.

44.—The Council shall present the yearly accounts (up to the 31st of July preceding) at the Annual General Meeting in October of each year, after they have been audited by a professional Accountant, appointed by the members at the Closing Business Meeting in May.

Trustees.

45.—The capital, stock, and funds of the Institution shall be vested in the names of three Trustees, to be elected from time to time as vacancies occur by the members of the Institution at a General Meeting called for that purpose. All mortgages and other securities shall be taken in the names of such Trustees; and on any new appointment the funds shall vest in the newly-appointed Trustee or Trustees jointly with the continuing or remaining Trustee or Trustees.

Investment of Funds.

46.—The Finance Committee may, with the consent of the Council, invest in the names of the appointed Trustees of the Institution any moneys not immediately required for the purposes of the Institution, in or upon any approved securities.

ALTERATIONS TO CONSTITUTION AND BYE-LAWS.

47.—Alteration in or addition to the Constitution and Bye-Laws may be made only by resolution of the Members at the

Closing Business Meeting in May, after notice of the proposed alteration or addition has been announced at the previous General Meeting.

The resolution may be modified by the Council meanwhile, should they so desire; but in this case it shall be read at the Closing Business Meeting in May in its original form before it is proposed in the amended form.

Such resolutions shall be stated in the notice calling the intervening Council Meeting, and also in the notice calling the Closing Business Meeting in May.

Vote by Proxy

Any Member unable to be present at the meeting at which such alterations are to be considered, but who is nevertheless desirous of recording his opinion thereon, shall be allowed to vote by proxy, such proxies shall be in Form J in the Appendix, which may be had on application to the Secretary, and may be used by any Member present at the meeting on behalf of the absent Member, and counted by the Chairman as of equal value with votes given in the manner provided in Bye-Law 19.

THE GOLD MEDALS.

RULES.

(Revised at Council Meeting held on 15th April, 1901.)

1.—That papers read by members of the Council shall be eligible for the Gold Medals' Award.

2.—That the medals shall be awarded by the vote of the Council given at a meeting of the Council at which the business has been specially noted on the circular convening the meeting.

3.—That when the Council proceeds to award the medals, authors of papers who are members of the Council shall not be present nor vote at such Council meetings.

4.—If at the meeting convened the Council is unable to agree, or considers it desirable, the matter may be deferred for consideration at a future meeting.

5.—That the medals shall be awarded annually, provided the papers are, in the opinion of the Council, worthy of the award, but not otherwise. Papers by authors who have already received a gold medal shall not be eligible for a medal till after the expiration of six years from the date of the previous paper for which the medal was awarded.

APPENDIX TO BYE-LAWS.

FORM A. (BYE-LAW 1.)

Name (in full)
Profession or Occupation and where Employed
Address
being desirous of admission into the North-East Coast Institution of Engineers and Shipbuilders, we, the undersigned, propose and recommend that he shall become*
thereof. We know him to be†
and eligible for the proposed membership.

* A Member, Associate, or Graduate.

† A Principal, Manager, or Draughtsman, etc. See Articles V., VI., and VII. of Constitution.

	FROM PERSONAL KNOWLEDGE.	SECTION OF MEMBERSHIP
Proposed by		
Supported by Three Members or Associates.		

Dated this day of

(*When a Graduate is proposed the age last birthday should be stated.*)

FORM B. (BYE-LAW 2.)

A. B. [Christian Name, Surname, Occupation, and Address in full] being at present a Graduate of the North-East Coast Institution of Engineers and Shipbuilders, and upwards of twenty-four years of age, and being desirous of becoming a Member of the said Institute, we, the undersigned [Members or Associates], recommend him, from *personal knowledge*, as a person eligible for the proposed Change of membership, because—

(*Here specify distinctly the Qualifications of the Candidate according to the spirit of the Rules of the Institution.*)

Signed _____ } Three [Members or Associates.]
_____
_____

Dated this day of 19

FORM C. (BYE-LAW 3.)

BALLOTING PAPER FOR MEMBERSHIP.

The Council having considered the recommendations for Membership of the following gentlemen, present them to be balloted for, viz.:—

Member, Associate, or Graduate.	Occupation.	Address.	Nominated by.	Supported by Three Members or Associates.

Strike out the names of such persons as you desire shall *not* be elected, and forward the list by post to the Secretary, or personally place it in the ballot-box at the Meeting.

FORM D. (BYE-LAW 4.)

Sir,—I am directed to inform you that on the day of you were elected a of the North-East Coast Institution of Engineers and Shipbuilders, but, in conformity with Bye-Law 4, your election cannot be confirmed, nor your name be added to the roll of membership, until you have paid your first annual subscription, the amount of which is £ : : , or, at your option, the Life Composition of £ : : .

Payment may be made to the Treasurer, Mr. _____

Address _____

I am, Sir,
Yours faithfully,

Secretary.

Dated 19

N.B.—In case of a Graduate, strike out "*or, at your option, the Life Composition of* £ : : "

FORM E. (BYE-LAW 9.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to draw your attention to Bye-Law 6, and to remind you that the sum of £
of your annual subscriptions remains unpaid, and that you are in consequence in arrear of subscription.

I am also directed to request that you will cause the same to be paid without further delay, otherwise the Council will be under the necessity of exercising their discretion as to using the power vested in them by the Rule above referred to.

I am, Sir,
Yours faithfully,

Secretary.

FORM F. (BYE-LAW 9.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to inform you that in consequence of non-payment of your arrears of subscription, and in pursuance of Bye-Law 9, the Council have determined that unless payment of the amount (£) is made previous to the day of next, they will proceed to declare that you have ceased to be a member of the Institution.

But, notwithstanding this declaration, you will remain liable for payment of the arrears due from you.

I am, Sir,
Yours faithfully,

Secretary.

FORM G. (BYE-LAW 10.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to inform you that they feel it their duty to advise you to withdraw from the Institution, or otherwise they will be obliged to act in accordance with Bye-Law 9 (or 10, as the case may be).

I am, Sir,
Yours faithfully,

Secretary.

FORM H. (BYE-LAW 11.)

BALLOTING LIST.

PRESIDENT.—ONE NAME only to be returned, or the vote will be lost.

——— President for the current year (eligible for re-election.)*

——— } New Nominations, from whom to select ONE.
——— }
——— }

VICE-PRESIDENTS.—EIGHTEEN NAMES only to be returned (including the fifteen who remain in office), or the vote will be lost.

——— }
——— }
——— } Fifteen Vice-Presidents remaining in office. These do not require to be voted for at this election, as their term of service has NOT yet expired.
——— }
——— }
——— }

——— }
——— } Three Vice-Presidents retiring, eligible for re-election.
——— }

——— }
——— }
——— } New Nominations, from whom to select THREE.
——— }
——— }

TREASURER.—ONE NAME only to be returned, or the vote will be lost.

——— Treasurer for the current year, eligible for re-election.

——— }
——— } New Nominations, from whom to select ONE.
——— }

ORDINARY MEMBERS OF COUNCIL.—FIFTEEN NAMES only to be returned, including the ten who remain in office.

——— }
——— }
——— }
——— }
——— } Ten Ordinary Members of Council remaining in office. These do not require to be voted for at this election, as their term of service has NOT yet expired.
——— }
——— }
——— }
——— }
——— }

——— }
——— }
——— } Five Ordinary Members of Council retiring, and NOT eligible for re-election.
——— }
——— }

——— }
——— }
——— } New Nominations, from whom to select FIVE.
——— }
——— }

* To be crossed out before issue when the President is not eligible for re-election.

N.B.—(*a*) The names of those who remain in office will be counted in the total number required without being re-written by the voter.

(*b*) Any list having either MORE or LESS than the required number of names voted for in any section will be disqualified for that section.

(*c*) Votes as President for a person who is not elected will count for him as a Vice-President.

(*d*) Votes as Vice-President, or Treasurer, for persons not so elected, will count for them as Ordinary Members of Council, unless they have just completed a term of office in that capacity.

(*e*) This list, duly filled in, may be returned to the Secretary by post, or handed to him, so as to be on the Council table before the commencement of the scrutiny, which is appointed to take place in the Council Room, at 8 p.m., on 19

(*f*) A copy of this list shall be posted at least Seven Days previous to the Annual Meeting to every Member and Associate, who may erase any name or names from the list and substitute the name or names of any other person or persons eligible for such respective offices, but the number of persons on the list after such erasure or substitution must not exceed the number to be elected to the respective offices.

Secretary.

FORM J. (BYE-LAW 45.)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

FORM OF PROXY.

FOR VOTES ON ALTERATIONS TO CONSTITUTION OR BYE-LAWS.

I,....., being [an Honorary Member, Member, or Associate] of the above Institution, do hereby appoint Mr..... who is [an Honorary Member, Member, or Associate] of the same Institution, to act as my Proxy, and record my Vote at the General Meeting of the Institution, to be held on the... .....day of ....., 18....., and at any adjournment thereof.

Signature.....

Address.....

.....

.....*Secretary.*

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

Supplementary Bye-Laws Relating to the Graduate Section.

I.—The Graduate Section shall be controlled by the General Bye-Laws of the Institution, and the following Bye-Laws are supplementary to these.

This Section shall be open to all members of the Institution who are under twenty-six years of age, who shall be at liberty to express their views upon any subject brought before the General Meetings of the Section.

Officers by Ballot.

II.—The Officers of the Section shall be elected from and by the Graduates, in accordance with the Form given in the Appendix, and shall consist of one Chairman, one Honorary Secretary, and seven Committee-men. The Committee shall have power to select one of its members to act as Assistant Honorary Secretary if required.

Election of Officers.

III.—(*a*) The Officers shall be elected annually, and shall all be eligible for re-election until the age limit is reached.

Rider to General Bye-Law No. 11.

(*b*) Any voting paper returning either more or less than one Chairman, one Honorary Secretary, and seven Committee-men shall be disqualified.

General Meetings.

IV.—The Annual General Meeting shall take place as early as possible after that of the Institution in the month of October, and the Closing Meeting shall be held prior to the Closing Business Meeting of the Institution in May.

Special General Meetings.

V.—A Special General Meeting may be convened at any time by the Committee. The business discussed at such Special Meetings shall only be that indicated on the notice calling the meeting.

Quorum.

VI.—Nine members shall constitute a quorum for the purpose of a General Meeting.

Excursions.

VII.—Excursions shall be arranged during the Session as the Committee may find expedient. Any Graduate wishing to introduce a friend at such excursions must submit the name of his friend to the Committee at least three clear days before the date of the excursion.

Seven clear days' notice of every excursion shall be given to every member of the Graduate Section.

COMMITTEE MEETINGS.

Committee Meetings.

VIII.—The Committee shall meet at as early a date as possible after the holding of a General Meeting, and on other occasions when the Chairman shall deem it necessary, being summoned in either case by circular, stating the time of meeting and the business so far as is known. All discussions of a personal character in the Committee shall be considered and treated as being strictly confidential.

Four members of Committee, including the Chairman, shall form a quorum.

Duties of Hon. Secretary.

IX.—The Honorary Secretary shall act under the direction and control of the Committee. He shall attend all Meetings, Committee and General, and shall take minutes of the proceedings and enter them in proper books provided for the purpose. He shall write the correspondence of the Graduate Section and Committee (excepting that arranging for excursions, which shall be arranged by the Secretary of the Institution). He shall keep a stamp account book, which on all occasions shall be open to the inspection of the Secretary of the Institution.

PAPERS.

Synopsis of Papers to be read.

X.—The author of a paper shall forward to the Honorary Secretary, at least fourteen days before the date of the reading of the paper, its title and a synopsis of the contents; a copy of the synopsis to be forwarded to every Graduate, together with the notice convening the meeting at which the paper is to be read.

Copies of Papers to be forwarded to the Secretary of the Institution.

XI.—Each Paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and to be signed by the author. The date on which the paper was read must be inserted after its title.

All papers submitted to the Graduate Award Committee shall be placed in the hands of the Secretary of the Institution not later than the 31st of May in each year.

Of these papers submitted to the Graduate Award Committee, either one or two may be recommended to be printed as an Appendix to the current volume of the Transactions of the Institution, the Council reserving the right to decline to give any award or to print any of the papers should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission, is entirely at the option of the author of such paper, but if it be published without the sanction of the Council, it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the Technical Journals the permission of the Council must be previously obtained and the name of the Institution must be attached.

APPENDIX.

GRADUATES' BALLOTING LIST.

CHAIRMAN.

*_____ (E)
_____ ( ) } Nominations from whom to select ONE.

HON. SECRETARY.

*_____ (E)
_____ ( ) } Nominations from whom to select ONE.

COMMITTEE.

*_____ (S)
*_____ (EE)
*_____ ( )
_____ ( )
_____ ( )
_____ ( )
_____ ( )
_____ ( ) } Nominations from whom to select SEVEN.

NOTES.

1.—Any list having either more or less than the required number of names will be disqualified. (See Supplementary Bye-law III.).

2.—All voting papers must be returned to the Secretary of the Institution on or before the day of , 19 .

3.—No signature must be put on this paper.

4.—* Signifies a member of the old committee.

5.—(E) Denotes Engineer; (EE) Electrical Engineer; (S) Ship builder.

6.—A copy of this list shall be posted, at least fourteen days previous to the Closing Meeting of the Session, to every Graduate, who may erase any name or names from the list and substitute the name or names of any other person or persons eligible for such respective offices, but the number of persons on the list after such erasure or substitution must not exceed the number to be elected to the respective offices.

7.—Votes as Chairman or Hon. Secretary, for persons not so elected, will count for them as members of committee.

THE LIBRARY AND READING ROOM RULES.

Committee.

1.—The Library and Reading Room shall be managed by a Committee, called the Library Committee, who shall have charge of all books, papers, specimens, etc., which may belong to the Institution. It shall consist of five members of the Institution, of whom at least two shall be members of Council.

Property.

2.—The books and other property of the Library shall be vested in the Trustees appointed by the Institution.

Appointment of Committee.

3.—The Library Committee shall be appointed annually, at the first meeting of the Council in each Session. No member who has served on the Committee for three years in succession shall be eligible for re-election until after an interval of one year. The Chairman shall be elected by the Council.

Librarian.

4.—The Secretary of the Institution shall be Librarian, and shall also act as Secretary to the Library Committee. Three members of the Committee shall form a quorum.

Duties of Committee.

5.—The Library Committee shall be responsible for the binding and purchasing of books, periodicals, papers, etc., and for the expending of all money voted by the Council for its use. It shall appoint an attendant who shall act as Assistant Librarian. It shall make Rules for the management of the Library, subject to the approval of the Council, and present an annual report to the first meeting of the Council held after the annual scrutiny of the books referred to in Rule No. 13.

Hours of Opening and Closing, etc.

6.—Except when closed by special order of the Library Committee, or when the Council is sitting, the Library and Reading Room shall be open for consulting, borrowing, or returning books, every week day as follows:—

FROM OCTOBER 1ST TO MAY 31ST.

Monday ... Tuesday ... Wednesday ... Friday ...	From 10 a.m. to 8 p.m.
Thursday ...	From 10 a.m. to 1 p.m
Saturday ...	From 10 a.m. to 1 p.m. and from 3 p.m. to 9 p.m.

FROM JUNE 1ST TO SEPTEMBER 30TH.

Monday ... Tuesday ... Friday ...	From 10 a.m. to 5 p.m
Wednesday ...	From 10 a.m. to 8 p.m.
Thursday	From 10 a.m. to 1 p.m.
Saturday ...	From 10 a.m. to 1 p.m. and from 6 p.m. to 9 p.m.

The Rooms will be closed on Christmas Day and the day following; New Year's Day and the day following; Good Friday and the day following; Monday and Tuesday in Easter week and Whit week; on Tuesday, Wednesday, Thursday, Friday and Saturday in the Race week of June; and from the fourth Saturday in July to the second Saturday in August inclusive, as mentioned in Rule No. 13.

Lending of Books.

7.—Books shall not be lent to any persons except Members, Associates, or Graduates of the Institution, but a person entitled to borrow a book may send a messenger with a signed order for it.

Visitors.

8.—Each member shall be entitled to introduce a friend to the Reading Room, whose name shall be written in the Visitors' Book, together with that of the member introducing him.

Reference Books.

9.—The books marked with an asterisk in the Catalogue shall be kept only for consultation in the Library, and shall not be lent. Pending the preparation of a Catalogue, the Librarian shall be instructed by the Committee as to which books shall be withheld from circulation.

Unbound Books.

No periodicals, magazines, or pamphlets shall be issued for circulation until after they have been bound and added to the Lending Library.

Register of Books Lent, etc.

10.—The Librarian shall keep a register in which he himself or the attendant shall enter the titles of the books lent, the date of lending, the name of the borrower, and the date of the return of the book to the Library. The borrower of the book or the bearer of his order shall initial the entry of such borrowing, and the Librarian or the attendant shall initial the date of the return of the book.

Number Lent to each member.

11.—No person shall borrow or have in his possession at one time more than two volumes belonging to the Library.

Return of Books.

12.—No member shall retain a book longer than fourteen days, excluding the day of issue. He shall be responsible for the safe return of the book, and if it be damaged or lost he shall make good the cost of such damage or loss.

Yearly Inspection of Books.

13.—All books belonging to the Library shall be called in for inspection, and the lending out of books shall be suspended from the fourth Saturday in July to the second Saturday in August inclusive, in each year, and members shall be required by notice to return all books in their hands before the period mentioned.

Fine.

Members failing to comply with this injunction shall pay a fine of two shillings and sixpence.

14.—Members are requested, when in the Reading Room or Library, to contribute to the general comfort by carefully abstaining from loud talking and noise of any kind. Smoking is not permitted in the Library.

Members in Arrears.

15.—Any member being twelve months in arrears with his subscription to the Institution shall not be at liberty to use the Library or Reading Room after the commencement of the first Session following.

N.B.—The foregoing Rules may be amended at any time by the Library Committee with the sanction of the Council.

NORTH-EAST COAST INSTITUTION

OF

ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

The Twentieth Session of the Institution was opened on the evening of Friday, October 23rd, 1903, with a Conversazione and Ball, at the invitation of the President (John Tweedy, Esq., J.P.) and Mrs. Tweedy, in the Assembly Rooms, Westgate Road, Newcastle-upon-Tyne, and was attended by a large assemblage of ladies and gentlemen.

FIRST GENERAL MEETING OF THE SESSION HELD IN THE LECTURE HALL OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY EVENING, NOVEMBER 13TH, 1903.

JOHN TWEEDY ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the Closing Business Meeting of the Nineteenth Session, held in Newcastle-upon-Tyne on the 22nd of May, 1903, which were confirmed by the members present and signed by the President.

The ballot for new members having been taken the PRESIDENT appointed Mr W. H. Dugdale and Professor R. L. Weighton to examine the voting papers, and the following gentlemen were declared elected:—

MEMBERS.

Abbott, Henry, Engineer, Lieut. R.N., H.M.S. "Mercury," Portsmouth.

Agnew, T., Engineer, Capt. R.N., H.M. Steam Reserve, Malta.

Avery. Thomas, Constructor, Royal Indian Marine Dockyard, Kidderpore, Calcutta.

Boyd, William, Engineering Inspector, 25, Woodbine Avenue, Gosforth, Newcastle-upon-Tyne.

Brookfield, J. W., Ship Draughtsman, 3, Northumberland Square, North Shields.

Clift, Arthur S., Engineer, Dynamo Department, c/o Messrs. Siemens Bros. & Co., Ltd., Woolwich.

Coleman, A. Charles, Electrical Engineer, 3, Balmoral Terrace, Gosforth, Newcastle-upon-Tyne.

Crammond, A., Marine Engineer, Tyne Dock Entrance, Corstorphine Town, South Shields.

Curgenven, L. W., Engineer, Lieut. R.N., c/o The Admiralty, Whitehall, London, S.W.

Grey, Robert, Engineer, 67, De Grey Street, Newcastle-upon-Tyne.

Guyatt, E. G., Engineer, Lieut. R.N., H.M.S. "Nelson," Portsmouth.

Hall, F. M., Consulting Engineer, 8, Wentworth Terrace, South Shields.

Hastings, James F. A., Engineer, Lieut. R.N., H.M.S. "Surprise," Malta.

Laws. B. C., Naval Architect, Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne.

Lonnon, W., Engineer, Commander R.N., H.M.S. "Orion," Malta.

McKlintock, E. E., Engineer, Tyne Commissioners, Howdon Yard, Howdon-on-Tyne.

Murray, David, Supterintendent Engineer, 17, Denwick Terrace, Tynemouth.

Pill, Joseph H., Engineer, Commander R.N., 139, Park Road, Newcastle-upon-Tyne.

Richardson, James William, Engineer and Shipwright, 53, Linskill Terrace, North Shields.

Smith, Charles R., Superintendent Engineer, 4, Belgrave Parade, Newcastle-upon-Tyne.

Sheret, William Robert, Ship Draughtsman, 15, Allworthy Avenue, Belfast.

Simpson, James M., Engineer, Lieut. R.N., c/o The Admiralty, Whitehall, London, S.W.

Wallace, John, Engineer, 11, Havelock Street, Newcastle-upon-Tyne.

Watt, Alex. James, Engineer, 15, Croft Terrace, Jarrow-on-Tyne.

Willcox, F. A., B.Sc., Consulting Engineer, 18 Holinlands Park, Sunderland.

Wurl, Max. Engineer, 44, Burdon Terrace, Newcastle-upon-Tyne.

GRADUATES TO MEMBERS.

James, William E., Shipbuilder, 6, Park Terrace, Gateshead-on-Tyne.

Milne, George M., Ship Draughtsman, 18, Kirton Park Terrace, North Shields.

Robson. George, Engineer, 155, Princess Street, Ipswich.

Sanders, H. W., E. Draughtsman, 48, Cardigan Terrace, Heaton, Newcastle-upon-Tyne.

ASSOCIATES.

Pilditch, Alfred, Accountant, Grange Villa, Jarrow-on-Tyne.

Walton, John Jos., Lloyd's Representative, Lindisferne. Holly Avenue, Whitley Bay.

Weiss, T. L., Marine Engineer, 17, Sandhill, Newcastle-upon-Tyne.

GRADUATES.

Cooper, William L., Apprentice Engineer, Park House, Jarrow-on-Tyne.
Crawford, T. W., Engineer Draughtsman, 10, Haldane Terrace, Newcastle-upon-Tyne.
Dyke, F. S., Apprentice, Engineer, Dene Lodge, Walker-on-Tyne.
Hobson, J. W., Apprentice Draughtsman, Iris Cottage, Edward Gardens, South Benwell, Newcastle-upon-Tyne.
James, Charles A., Ship Draughtsman, 6, Park Terrace, Gateshead-on-Tyne.
Johnston, James McFetridge, Ship Draughtsman, 62, Beechfield Street, Belfast.
Mowll, Harold, Apprentice Engineer, The Green, Wallsend-on-Tyne.
Reed, Robert, Engineer, 57, Warrington Road, Newcastle-upon-Tyne.
Robertson, R. A., Engineer Draughtsman, 5, Greenmount Terrace, Beeston Hill, Leeds.
Tchighianoff, Alec., Apprentice Engineer, 45, Lovaine Place, Newcastle-upon-Tyne.
Thomas, Robert C., Mechanical Engineer, 21, Wentworth Place, Newcastle upon-Tyne.
Webb, Edmund, Apprentice Engineer, 16, Abbey Terrace, Gateshead-on-Tyne.
Whiting, W. R. G., Apprentice Shipbuilder, 37, Hawthorn Street, Newcastle-upon-Tyne.
Wilson, James J. Vernon, Apprentice Engineer, 62, Alexandra Road, Upper Norwood, London.

THE PRESIDENT'S CONVERSAZIONE.

Mr. JAMES STEWART said—On behalf of the members of this Institution I beg to move that a very hearty vote of thanks be given to our President and Mrs. Tweedy for their splendid hospitality on the occasion of the conversazione held recently. These gatherings afford an opportunity for pleasant social intercourse and are, therefore, usually of an enjoyable description, but it was a subject of general remark that this conversazione was a particularly hearty and happy one. The members and their friends thoroughly enjoyed themselves, and we are very much indebted to our esteemed President and Mrs. Tweedy for giving us the opportunity of meeting and spending such a pleasant evening.

Mr. J. H. HECK said—I rise in order to second the motion so ably proposed by my friend, Mr. Stewart, that a hearty vote of thanks be given to Mr. and Mrs. Tweedy. Quite a number of ladies and gentlemen came from all parts of the country to attend the conversazione and there is an unanimous opinion amongst all that it is one of the happiest that has been held. There was a general feeling of indebtedness to Mr. and Mrs.

Tweedy for the pleasure their kindness had afforded. A conversazione is a pleasant function which enables everyone to meet—young and old and from all parts, to shake hands, and exchange greetings. In my opinion, it does much good to an Institution of this kind and I for one hope it will not be abolished. I have very great pleasure in seconding the motion that on behalf of the members of this Institution a hearty vote of thanks be given to Mr. and Mrs. Tweedy.

The motion was carried with hearty acclamation.

The PRESIDENT—I need not say that to my wife, who, as you know, is the daughter of a former occupant of this chair, and to myself, it has been a source of great pleasure indeed to have been the means of giving an hour or two of recreation to the hard-worked members of this Institution. I quite agree with Mr. Heck that any function which brings together the members, their wives, daughters, and cousins, is of the greatest value. The opportunity of meeting the cousins of their friends to commence with is an advantage. It is said that all work and no play makes dull boys. I think that statement is equally true of the older as of the younger members—Professor Weighton, for instance, and myself and even older men are the better for such intercourse, and I also hope that the function will not be discontinued. I also agree with Mr. Heck that a conversazione, after all, is, perhaps, better than an Institution dinner; it brings our women folk into the charmed atmosphere in which their men folk shine so brightly. I thank you heartily on behalf of my wife and myself. But I think you must allow me to thank Mr. Muir, who so kindly undertook the work of master of ceremonies, and the other gentlemen who acted as stewards, for the excellent way in which they carried out their work. I am told that they are most successful caterers, and, before I sit down, I would like you to join with me in according a hearty vote of thanks to these gentlemen who gave so much of their time to your pleasure and mine.

This proposal was also carried by acclamation.

The SECRETARY submitted the Annual Report and Balance Sheet, which were taken as read, and were as follows:—

COUNCIL REPORT.

(Nineteenth Session, 1902-1903.)

The Nineteenth Session of the Institution was opened on Friday, October 24th, 1902, with an inaugural address delivered by the new President (John Tweedy, Esq.), and during the Session the following papers were read and discussed:—

"Fire Extinguishing Apparatus for Ships." By Mr. John H. Heck.
"On Large Stop Valves for High Pressure Steam." By Mr. J. Hamilton Gibson.
"Minimum Metacentric Heights in Small Vessels." By Mr. Joseph H. Pescod.
"Loss of Power in Steamship Vibrations." By Mr. J. Denholm Young.
"A Displacement Table for use with the Tchebycheff Formula." By Mr. F. H. Alexander.
"Some Points in the Construction of Large Steel Steamers and the Riveting of Lapped Butts." By Mr. Archibald Hogg.

The engineering gold medal for the Eighteenth Session was presented to Mr. D. B. Morison for his paper on "The Unsatisfactory Condition of the Engineering Branch of His Majesty's Navy."

The annual dinner was held in Newcastle-upon-Tyne, on Friday, January 16th, 1903. In view of the decreasing number of members attending this function the Council has decided to abandon the idea of holding an Institution dinner during the current session.

In reply to a request from the Engineering Standards Committee, Mr. Summers Hunter was appointed to act as engineer representative for this Institution on the Sub-Committee on Ship's Tests. Mr. John Tweedy was also appointed to represent the Institution on the Sub-Committee appointed to consider the "Standardisation of Pipe Flanges."

The term for which the representatives of this Institution had to serve on Lloyd's Technical Sub-Committee having expired, the Council was called upon to elect four representatives to serve for a further period of four years. The following gentlemen were again elected:—

Shipbuilders:—Messrs. W. H. Dugdale and Henry Withy.
Engineers:—Messrs. J. W. Reed and John Tweedy.

The report of the work done during the last four years by the Committee will be found on page 229, Vol. XIX., of the *Transactions.*

In consequence of the establishment of an Education Committee under the provisions of the Education Act, 1902, the Technical Education Committee and its Sub-Committees of the Northumberland County Council having ceased to exist, our representatives on the Technical Committee have been withdrawn.

The matter of the education in technical science and the general training of pupils and apprentices entered or preparing to enter engineering and shipbuilding works has engaged the the attention of the Council, and the following resolution was brought before the general body of members of the Institution for approval at the closing Business Meeting of the Session held in Newcastle-upon-Tyne, on May 22nd, 1903:—

> "That an Educational Committee of this Institution be formed to consider questions which may arise in regard to the education in technical science and general training of youths entered or preparing to enter engineering and shipbuilding works; to discuss such questions with public and other educational bodies, and to advise upon them. The Committee to have powers to add to its numbers, and to associate itself by sub-committee or otherwise as may be arranged with similar Committees of kindred Institutions."

This was unanimously adopted, and the following gentlemen, who were nominated by the Council, were duly elected to form the Committee:—Mr. Henry Clark, Mr. W. H. Dugdale, Mr. G. B. Hunter, Mr. Summers Hunter, Mr. F. T. Marshall, Mr. D. B. Morison, Mr. Robert Thompson, Mr. John Tweedy, Mr. R. L. Weighton, M.A., and Mr. Henry Withy.

The Committee has been already at work and it is intended to place before the Institution at an early date the results of its deliberations.

The attention of the Council having been called to the Graduate Supplementary Bye-Law XI., relating to the reading of papers in that section, it was found that a modification of it was necessary. A Committee was formed to consult with the Committee of the Graduate section and revise and amend it to meet present requirements. This was done and the Bye-Law in its revised form was agreed to at the closing business meeting of last session. It now reads as follows:—

XI.—Each paper read before the section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and to be signed by the author. The date on which the paper was read must be inserted after its title.

All papers submitted to the Graduate Award Committee shall be placed in the hands of the Secretary of the Institution not later than 31st of May in each year.

Of these papers submitted to the Graduate Award Committee, either one or two may be recommended to be printed as an Appendix to the current volume of the *Transactions* of the Institution, the Council reserving the right to decline to give any award or to print any of the papers should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission, is entirely at the option of the author of such paper, but if it be published without the sanction of the Council, it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the Technical Journals the permission of the Council must be previously obtained and the name of the Institution must be attached.

The financial statement for the year ending July 31st, 1903, is appended to this report. The Council regrets having to state that the sum of £30 19s. 6d. for subscriptions in arrears has had to be written off as irrecoverable, and in addition there is still due to the Institution the sum of £80 6s. 6d. for unpaid subscriptions for last year.

During the year the following additions have been made to the roll of Members:—Life Member, 1; Members, 53; Associates, 5; Graduates, 28; and 13 Graduates have been passed into the Members' section.

The Council regrets having to record the loss by death of the following:—Mr. F. C. Marshall (Past President); Mr. Sampson Fox, Life Member. Members: Mr. John William Booth, Mr. John M. Campbell, Mr. Henry Charlton, Mr. William Lumley, Mr. Percival Allan, Mr. Albert S. Jackson and Mr. John Bulmer. Associate: Mr. John Nixon. Graduate: Mr. Campbell Houston.

The Institution has also lost by resignations and other causes 53 Members, 7 Associates and 12 Graduates.

Owing to the death of Mr. F. C. Marshall a vacancy occurred in the Trusteeship of the Institution, and Mr. Henry Withy (Past President) was appointed to act in his stead.

Graduate Section.

During the Fourteenth Session of the Graduate section nine meetings were held.

At the opening meeting the Chairman (Mr. George Nelson) delivered his address, the subject being, "The Engineer of the New Century," and during the session the following papers were read and discussed:—

"Comparison between different Systems of Charging for Electricity." By Mr. R. Robson.
"On Rudders." By Mr. H. Bocler.
"A short description of Street Railway Work." By Mr. P. F. Allan.
"Compound Locomotives." By Mr. H. J. Potts.
"The growth of Automobilism in Public Highways." By Mr. A. E. Berriman.
"The Stresses produced in the working parts of a Marine Engine and the Methods of determining the same." By Mr. T. C. Fortune.
"Some Notes on Economical Propulsion and Powering of Ships." By Mr. H. B. Donaldson.

The following places of interest were visited:—

The Newcastle-upon-Tyne Electric Tramways Power Station.
The Electric Works of Messrs. Ernest Scott, Mountain & Co., Newcastle-upon-Tyne.
The Works of Messrs. The Sunderland Forge and Engineering Co., Sunderland.

The thanks of the Institution are due to the principals and officials of these establishments for the kindness and courtesy extended to the junior members.

The following awards were presented to the authors of papers read before this section during the thirteenth session:—

Books, etc., to the value of £3 to Mr. George Robson for his paper on "Superheated Steam and Superheaters."
Books, etc., to the value of £2 10s. to Mr. N. R. Temperley for his paper on "The Application of Electric Power to the Driving of Factories."
Books, etc., to the value of £1 10s. to Mr. A. W. Bowerbank for his paper on "The Auxiliary Machinery of Ships."

Mr. W. H. Waddingham was elected Chairman and Mr. A. E. Berriman Honorary Secretary of this section for the current year.

The Balance Sheet for Session ending 31st July, 1903.

Liabilities.

	£	s.	d.	£	s.	d.
Gold Medals' Fund—						
Amount at 31st July, 1902 .. £302 8 8						
Interest on Investment ... 9 0 9						
	311	9	5			
Less—Medal awarded	5	10	0			
				305	19	5
Graduates' Award Fund—						
Amount at 31st July, 1902 ... £222 11 7						
Interest on Investment ... 7 2 3						
	229	13	10			
Less—Awards for Papers	3	0	0			
				226	13	10
Payments by Life Members and Associates—						
Amount at 31st July, 1902	231	0	0			
Add Life Member this Session	21	0	0			
				252	0	0
General Capital as at 31st July, 1902	2,507	7	7			
Revenue Account	267	16	4			
				2,775	3	11
				£3,559	17	2

Audited and certified,
R. W. SISSON, F.C.A.

Newcastle-upon-Tyne,
28th October, 1903.

Assets.

	£	s.	d.	£	s.	d.
Subscriptions in Arrear—						
Session 1902-1903				80	6	6
Stock of Transactions, valued at				207	10	3
Office and Library Furniture,						
Safe, etc., as at 31st July, 1902	121	1	1			
Less—Depreciation	12	1	1			
				109	0	0
Books in Library—						
As at 31st July, 1902 ... £336 17 3						
Less—Depreciation ... 33 13 9						
	303	3	6			
Additions this Session—						
Purchases £6 17 8						
Books received in exchange for Transactions 30 0 0						
	36	17	8			
				340	1	2
Tyne Improvement Commissioners—Investment in respect of the following Accounts, viz.:—						
Gold Medals' Fund	274	0	0			
Graduates' Award Fund and Payments by Life Members and Associates	331	0	0			
General Capital—						
As at 31st July, 1902	1,700	0	0			
				2,305	0	0
Cash—At Bank				517	19	3
				£3,559	17	2

NORTH-EAST COAST INSTITUTION OF

STATEMENT OF RECEIPTS AND PAYMENTS

Receipts.

	£ s. d.	£ s. d.
To Balance from last Account—		
At Bank		204 11 6
„ Subscriptions received for Session 1902-1903—		
256 Members at £2 2s. £537 12 0		
590 Members „ £1 1s. 619 10 0		
144 Associates „ £1 1s. 151 4 0		
105 Graduates „ 10s. 6d. 55 2 6		
1,095	1,363 8 6	
„ Association of Foremen Engineers and Draughtsmen—		
One year's Subscription	20 0 0	
„ Life Member (W. A. Fairbairn)	21 0 0	
„ Arrears from Session 1901-1902—		
8 Members at £2 2s. £16 16 0		
43 Members „ £1 1s. 45 3 0		
3 Associates „ £1 1s. 3 3 0		
2 Graduates „ 10s. 6d. 1 1 0		
	66 3 0	
		1,470 11 6
„ Transactions sold this Session	43 16 2	
„ Copies of Members' Papers supplied	36 18 7	
		80 14 9
„ Tyne Improvement Commissioners—		
One Year's Interest to 21st June, 1903, on £605, at 3½ per cent.	21 3 6	
Viz.:—Medal Fund £274 0 0		
Graduates' Award and Life Members' Fund 331 0 0		
Less—Tax	1 4 11	
		19 18 7
One Year's Interest to 10th July, 1903, on £500, at 3¾ per cent.	18 15 0	
Less—Tax	1 1 9	
		17 13 3
One Year's Interest to 4th May, 1903, on £300, at 3 per cent.	9 0 0	
Less—Tax	0 10 11	
		8 9 1
One Year's Interest to 13th July, 1903, on £300, at 3¼ per cent.	9 15 0	
Less—Tax	0 11 3	
		9 3 9
One Year's Interest to 9th June, 1903, on £300, at 3¼ per cent.	9 15 0	
Less—Tax	0 11 9	
		9 3 3
One Year's Interest to 8th May, 1903, on £300, at 3½ per cent.	10 10 0	
Less—Tax	0 12 9	
		9 17 3
General Capital Invested ... £1,700		
		£1,830 2 11

ENGINEERS AND SHIPBUILDERS.

FOR SESSION ENDING 31ST JULY, 1903.

Payments.

	£	s.	d.	£	s.	d.
By Transactions and Papers—						
Lithographing	115	0	3			
Printing and Binding	186	2	1			
				301	2	4
„ Stationery and Circulars	73	19	10			
„ Reporting	17	8	0			
„ Rents—						
Offices and Electric Light Fittings	112	12	9			
Lecture Rooms	24	11	0			
Telephone	7	10	0			
				236	1	7
„ Rates, Gas, Electric Light, and Insurance...				31	7	2
„ Salaries—						
Secretary, Salary	400	0	0			
„ Commission	72	14	9			
Assistants'	42	17	0			
.. Postages, Stamps, Post Cards, Parcels, etc.	109	19	3			
,. Secretary's and Office Expenses, Coal, Cleaning, etc. ...	70	11	4			
„ Measured Mile Posts—Rent...	6	6	0			
„ Auditor's Fee	5	5	0			
„ Lantern Expenses	2	15	6			
				710	8	10
„ Library Account—						
New Books	6	17	8			
Bookbinding	17	16	1			
				24	13	9
„ Gold Medals' Fund—						
Gold Medal awarded				5	10	0
„ Graduates' Award Fund—						
Amounts awarded for Papers				3	0	0
„ Balance at Bank				517	19	3
				£1,830	2	11

The PRESIDENT—I move the adoption of these reports. Has any member any remarks to make upon them?

Mr. J. R. FOTHERGILL (Vice-President) said—I beg to second the motion. It has been my privilege on various occasions as a member of the Finance Committee to make a statement relative to the Institution's financial position. It is pleasing to find an increase in the membership, although not large, yet in proportion to past years. If you refer to the Balance Sheet you will note the number of members who have paid and those in arrears total 1,151, whereas the year prior they totalled 1,128 or an addition of 23 members; of course deaths, resignations and written off are in each case deducted. The increased membership would have shown much larger but for the unfortunate necessity of having to write off so many members two or more years in arrears.

The number written off this year considerably exceeds any prior year particularly in cash value representing a loss to the Institution of £31 and in addition to this you will note in the Balance Sheet there are still subscriptions in arrears amounting to over £80 although it is anticipated the greater part of this will be paid. I have no doubt to some extent the bad times we are experiencing will account for much, but if members would resign, instead of not paying their subscriptions and thus forcing their names being brought before the Council for consideration and erased from membership, it would add to their dignity and certainly be a more gentlemanly act.

Our financial position on the whole I think you will agree is very satisfactory.

You will observe we have £1,700 invested and in addition there is the Life members investment fund £126 also £300 of the £518 shown in the Balance Sheet as "Balance at Bank." This gives a total investment of £2,126 which brings in a very useful income per annum. I am sure you will agree this is a healthy position. Of course you will understand the Gold Medal and Graduates Award Funds are not covered in the above figures. The Finance Committee have continued their policy in writing down or taking off for depreciation 10 per cent. on furniture, books and transactions in stock which you will agree is a sound business course. You will observe we

commenced the year with a Balance brought forward of £204 11s. 6d. and we conclude with a Balance at the Bank of £517 19s. 3d. thus a net gain during the year of £313 7s. 9d., £300 of which has been invested. I have great pleasure in seconding the resolution that the Report and Balance Sheet be adopted.

The PRESIDENT—I do not think I can add anything to Mr. Fothergill's remarks regarding the financial statement, excepting to congratulate ourselves in that we appear to be £300 richer at the end of the Session than at the commencement. I hope this fact will not have the effect of causing any of us to relax our efforts in the interests of the Institution. We wish to fully maintain our balance, and to increase it if possible.

The motion was carried, *nem. con.*

The PRESIDENT delivered his Opening Remarks.

Mr. MAX WURL read a paper on "Technical Education in Germany."

THE PRESIDENT'S OPENING REMARKS.

The PRESIDENT, in opening the new Session, said—I wish to explain that the Council, after much consideration, has decided to hold all the meetings in Newcastle this year, instead of visiting the provinces, if I may dignify Newcastle by relating the other towns to it in that way. I doubt if I need make any opening remarks except to draw attention to the fact that we are now entering upon the Twentieth Session of the Institution. We have passed through nineteen years of good work. Nineteen years lie behind us, and I hope a brilliant future lies before us. Whether it is brilliant or not will depend, of course, entirely upon the energy and enterprise of the members. The Institution continues to take an active part in the technical affairs of the country. It still assists in Lloyds' Technical Committee. It is represented on the Board of Trade Committee and on the Standardization Committee. The Standardization Committee is very busily engaged in endeavouring to standardize the various manufactures of England. The work they have undertaken is work of tremendous importance, and I think they are making satisfactory progress. The Committee still has charge of the Measured Mile Posts, and it is now giving serious consideration to the question of the better educational training of engineers and shipbuilders. You know how successful were the efforts, in which this Institution was associated, in regard to the improvement in the position of engineers in the Navy. That issue was, I think, carried to a fairly successful termination. The Institution has now taken up the question of the better general education for the coming members of the Institution, and I hope in this case also they will succeed. The training of engineers is now perhaps the most important question which can occupy the attention of the Institution, and I hope that we as engineers and shipbuilders will see that it receives proper consideration.

Apart altogether from the reciprocal personal advantages to be derived from membership in an Institution of this kind, and

which, as the years roll on, increase in value, the members, through their Institution, also occupy an honourable place in the technical affairs of the country.

To an eager impatient young man it may sometimes seem that the achievements of the past had closed all the avenues to greatness in the future. But I do not think this is so. I think the Watts, the Stephensons, and the Armstrongs have left niches still unfilled. The niches are not less numerous. They are there waiting to be filled by the unknown names of the youths of the present. But they are placed a little higher up in the building. They are less accessible. More training and preparation, more plodding, and hard work is required to reach them and one work this Institution is capable of doing is in offering a helping hand to young men struggling to attain one of the niches still unfilled by the past. To-night we are to have a paper by a young member. Mr. Wurl is of German birth, but now resident in England, but after all we are all very much indebted to Germany—first, I think, for a good deal of the blood which runs in our own veins, and secondly, for their very successful solutions of many abstruse problems in applied science. It will be an advantage to our Institution to have in its *Proceedings* an account of the educational methods adopted in Germany. We welcome Mr. Wurl as a member and welcome his paper.

TECHNICAL EDUCATION IN GERMANY.

By MAX WURL, Member.

Read in Newcastle-upon-Tyne, on Friday, November 13th, 1903.

It must appear like boldness on my part to venture out of my line into educational fields, and almost like temerity to attempt the treatment of such a wide and difficult subject in the short time allowed for a paper. I attribute the honour of being asked by the President to read such a paper to the fact that I have myself obtained my general and technical education in Germany and that I have grown up with the later great developments and reforms in the technical educational system of my country.

Although I have to cut my remarks as short as possible from want of time, I cannot help expressing some general views on the problems involved—views which are naturally the product of my own impressions, but which, I dare say, coincide in general with the opinions expressed by German experts on these subjects.

One of these general views silently accepted by nearly all parties in Germany, is that the kind of technical education which can be conferred on a man depends mainly upon his general education; the latter being so to speak, the root and organ by means of which technical training is able to grow. All in all, the system of preparatory education is so closely connected with the professional training that I cannot avoid giving first a general description of the school system and its aims.

The educational system is now almost uniform throughout the German empire; the different confederate States, although holding their own reserved rights in that matter, have mostly followed the example of Prussia, the largest German State, which, under the government of the Hohenzollern, had held a leading position in education long before the empire was formed. In the following I will therefore speak mainly about the Prussian system.

I presume it is generally known that the Government in my country exercises a certain control over all schools. The control of the empire extends only so far as the examinations for the one year's service in the army are concerned. Each single State too, although contributing near 50 per cent. to the total subsidies, exercises only moderate control over its schools, which has admittedly had a most beneficial influence upon the general educational standard. In Prussia a school re-organization with extension of State control took place at the beginning of the nineteenth century; teaching then was recognised as a profession and a programme of school-work during stated periods was laid down for all schools. Since 1850 all teachers of private and public schools have to satisfy the Government officials of their scientific, technical and moral fitness to teach. Much to the benefit of technical education was the influence of the State exercised in reforming and modernizing the system of secondary schools, to which I shall come back later.

The State administration is in the hands of the Minister of Education, who directly controls the universities, the supervision of the secondary schools is carried out by Provincial School Colleges or controlling boards, and for the primary schools by the *Bezirks-Regierungen* (governing bodies of large provincial districts) both having separate inspectors. Laws, orders and regulations concerning elementary education are issued by the Provincial Government.

A general obligation on all parents to send their children to school from the completed sixth year of age has existed in Prussia since 1763. About thirty years later this was laid down by the Common Law Code (Allgemeines Landrecht). Provincial laws determine the minimum time for school attendance, which is generally eight years.

The principal subjects taught in elementary schools are German, religion, arithmetic, geometry, drawing, natural sciences, geography, history and singing. The total number of hours per week is from 20 to 32, including gymnastics for boys and needlework for girls.

A special, viz., higher category of these elementary institutions are the middle schools, to be found generally in towns (Bürgerschulen, etc.); the same subjects are taught in them but more extensively, modern languages are often included.

Middle schools must have at least five classes with not over 50 pupils in each.

All primary education is free and the fees charged in secondary schools only amount to about £5 to £6 per year. Nevertheless the quality of these latter institutions is so gnerally acknowledged that even people who could afford private tutors prefer sending their children to one of the existing schools, and even members of the Royal Family are sometimes attending such a public school.

The three types of secondary schools now in existence are: the *Gymnasium*, the *Realgymnasium*, and the *Oberrealschule*. *Vorschulen* or small preparatory schools, are often attached to these secondary schools. The scope of work and the course of study are uniform in each particular kind of school and the educational standard to be attained in each institution of the same name is identical throughout the country. The length of the full course of study is nine years additional to the three years preparation in the Vorschule.

The programmes of teaching of these three types of secondary schools, showing the different subjects taught and their weekly hours are given in the Appendices (Appendices I. to III., pp. 31 to 33). They show how much importance is laid on Latin and Greek in the classical Gymnasium, while in the Oberrealschule classics are excluded, sciences and modern languages being predominant, the Realgymnasium holds about the middle between the other two institutions.

The Gymnasium is the oldest of the three, and has grown out of old monk-schools, some Gymnasien can look back upon a history of 600 to 1,000 years. The instruction in the Middle Ages consisted purely in classics, other subjects were entirely excluded up to the beginning of the last century when mathematics and modern languages were introduced in the programme of teaching; but apparently that was not considered sufficient for the requirements even of that age, and the first "modern schools" were established at the same time under the name of higher *Bürgerschulen* and *Realschulen;* these could, however, not gain any importance as long as the Gymnasien has a monopoly in privileges. The old word "knowledge is power" seemed to have changed into "privilege is power"; during the main part of that century a continuous chase for privileges could be

perceived not only between the different institutions but even more between their pupils. Parents selected the school for their children, not with the view to give them the most adequate education, but to secure for them rights and certificates, and children grew up in the belief that these things were the real aim and end of all their school struggles. This tendency has not disappeared yet, but conditions are improving since the reform was earnestly taken in hand.

In 1877 the State conferred some valuable privileges on modern institutions and carried out a complete re-organization of the secondary schools in 1882. The former Realschulen were promoted to Realgymnasien and had to take up a nine years' course of study. At that time also the Oberrealschulen were called into existence, they were moulded from certain technical trade schools without Latin in which an improved course of study was introduced, also of nine years. So the difference between modern and classical high schools became by and by merely one of direction in the learning acquired.

The only question that could not be settled at that time was the conferring of privileges on the new institutions. The universities constantly refused admittance to graduates of modern schools except to some special studies in sciences.

This raised a long and interesting dispute about the educational value of classics. The objection to modern education was that it showed a tendency of being useful for future life, and the preference was given to classical education by the universities and others because it was supposed to be free from this tendency and to pursue higher, more ideal aims. I could never understand the meaning of this, although I come from a gymnasium myself; I do not see the principal difference between usefulness and ideals. The study of classics is also useful if it is able to bring nearer to our mind the splendour of old Greek and Roman culture, which forms such a great part in our arts and sciences. But we must not forget that these ages have ceased to be productive. We may select men to keep open the connection with the past, but the principal part of the intellectual army must advance forward to progress and new ideals.

The merit of having cleared the way for this advance, of having broken down old prejudices, belongs to the present German Emperor. His Majesty, with all the best sources of in-

formation at his command, devoted himself most ardently to the study of the educational problem. Mainly to the personal influence of the Monarch we owe the great step, made by the edict of 1901, which places all three classes of secondary schools practically on the same level. The certificate of maturity from either school grants admittance to all faculties at any German university or technical college, the few restrictions still existing for students coming from modern schools will perhaps also be removed in time.

In technical education itself there may be distinguished a lower, a middle, and a higher career.

The training is often commenced in continuation schools which have been mentioned already in connection with primary education. These schools give almost every workman an opportunity to improve his position; he may learn how to make technical sketches and drawings and how to read them, and he may thus complete his practical experience by theoretical instruction. The fees are very low, they amount to from 4s. to 6s. per half year for the evening classes. The employers have to allow their workmen to attend these schools. For admission only elementary-school training is required and no limit of age is enforced. So that a selection of the fittest is continually in operation among the workmen by these schools, giving opportunities to develop their abilities and become foremen, sea-going engineers, etc.

Technical institutions giving a more complete instruction of this kind have different names, as *Werkmeisterschulen* or *Maschinenbauschulen;* they are day schools and require the full time of the student. The training in them consists mainly in mathematics, mechanics, electricity, materials, description and explanation of engines, general principles of construction, drawing with construction of details. The course is 1½ to 2 years; suggestions have been made lately to reduce this time to one year only, because practical men after having passed a long course of study are often inclined to continue their life in the drawing office where they are less needed than in the shops; and the intention of these schools is to produce well educated mechanics.

The qualifications necessary for the drawing office or for superintending positions in works and factories can be obtai

in technical middle schools. These institutions had been rather neglected during the last part of the nineteenth century. Many of them (Provinzial-Gewerbeschulen) were practically swept away by the reform of the secondary schools, the Oberrealschulen mentioned above took their place, and no substitutes were created. That there was a great demand for them was shewn by the rapid growth of existing private institutions of this type outside of Prussia, another result was the undesired overcrowding of the technical high schools.

The first step for a reform was taken about 10 or 15 years ago when the *Verein deutscher Ingenieure*, a corporation of more than 17,000 German engineers elected a commission to study the question and offer suggestions for the re-organisation of the technical middle schools. The suggestions made, found appreciation by the Prussian Government, and we have now a good many of these schools as may be seen from the list in the Appendix IV. (page 33), giving places and names of such institutions existing in Prussia in 1901-2, and also the subsidies, they received during that year, amounting to over £22,000.

For admission as a student to these schools the certificate qualifying for the one year's service in the army, is required, which means a six years' successful attendance of a secondary school, exemptions from this rule may be made, after the latest regulation, and admission may be attained by passing an entrance examination. A second condition to be complied with before entering the reformed technical middle school is a two years' workshop practice, and attempts are being made now to provide for sufficient openings for that purpose in industrial works, in a similar way as it is done for the higher technical career to be treated later. All these conditions mainly refer to the State institutions, private technical middle schools naturally render the admission as easy as possible.

The instruction in technical middle schools is given on a more scientific basis than in the formerly mentioned Werkmeister-schulen and Maschinenbauschulen. It is not merely a communication of facts but given with a view to convey to the pupil also a proper understanding of the underlying principles of these facts. The course of study is only two years and the total fees for tuition are about £15, to which has to be added, of course, the money for books and living expenses, amounting to about £40 to £60 each year.

The qualifications obtained are quite sufficient for many practical purposes, which is shewn by the fact that a great number of our best known engineers have only had a technical middle school training, and that even now, despite the strong supply of academical men, middle school graduates often rise to leading positions. On the other hand it must be borne in mind that the higher career requires considerably more time and money, and it is certainly not our intention to give all our engineers an academical education. The keen competition with other Nations compels us to give every man an adequate education, with the smallest possible expenditure of national strength. This principle gives the technical middle school a very important place in the general system of education.

Graduates from technical middle schools or higher institutions will, as a rule, adopt the title *Ingenieur*. Although this title is free, *i.e.*, not hall-marked by the State, technical men with an inferior education are generally termed differently, as *Werkmeister*, *Maschinenmeister*, *Mechaniker*, etc. In the class of engineers, until recently, no distinction was made for the more highly educated academical engineer who has passed a technical college.

These colleges generally termed *Hochschulen* (technical high schools) are a product of the present day and were hardly known some 30 years ago. Some of them have been founded on former technical and art institutions as building academies, etc., which have existed for 100 years and more in Prussia and that is the reason why the Hochschule at Charlottenburg for instance could celebrate its 100 years' anniversary (centenar festivity) in 1899.

It was on that occasion that the right was granted to all Prussian Hochschulen to confer the degrees of *Dipl. Ing.* and *Dr. Ing.* with the intention of placing the hochschule on a level with the universities, and to raise the social position of their graduates accordingly.

The utility of these degrees may be doubtful, but it must be acknowledged that the selection of a profession very often depends on the reputation of such profession; and able men will often abstain from a study which is not in the best social repute. But engineering demands the best men and a Hochschule without a sufficient supply of brains would certainly prove a failure

leading to a national loss. From this point of view the attempt to improve the social position of the academical engineer appeared to be necessary.

The universities which had been the highest educational institutions for many centuries were recognized and highly respected everywhere. They conferred a dignity upon their graduates, but they did not provide for the technical training which was necessary for industrial progress. They followed their old principle to teach "science for its own sake" *i.e.*, not with the intention to serve a practical purpose, and since engineering did not agree very well with this principle it had been neglected or even ignored. But now when modern technical science had become a national necessity the question of adopting engineering subjects in the curriculum became imperative and attempts were made in this direction (Technical Institute in Göttingen). But it was too late, the Hochschulen had already completed what the universities intended to do. The idea of combining Hochschulen and universities arising at that time, was not carried out, mainly on account of the resistance shewn in the old classical centres.

The Hochschulen had to go their own way; their path was determined, but some obstacles had still to be removed in the form of traditional prejudices.

This was done sooner than it had been expected by either the "classicals" or the "moderns." The latter party had a great and powerful ally in the German Emperor. His Majesty played here an even more important part than in the modern school reform, mentioned before, which was just being completed at this time. He took much care to study the question thoroughly; and many private audiences with the prominent leaders of both parties were devoted to this subject.

To strengthen the position of the higher technical schools His Majesty as King of Prussia not only conferred the right on the Hochschulen to grant the degrees of "Dipl. Ing." and "Dr. Ing.", an example which has since been followed by all other German States, but also appointed Professors of Prussian Hochschulen "as life members of the Herrenhaus (House of Lords)." To explain what that means I must mention, that every university as an independent institution has the right to send a member to the Herrenhaus, and by taking the above step His

Majesty has placed the Hochschule politically on a level with the universities.

The aims of the technical high schools are to train the student to independent thought in technical affairs. He is taught to take a wide view in all of his considerations and all his doings, to avoid the mistake of one-sidedness which is but too common. All points, practical, theoretical commercial, etc., must be studied with equal care and thoroughness; a failure in any undertaking always shows that something has been overlooked or neglected, and on the other hand we may be sure of success, if we include in our considerations *all* the different conditions according to their importance.

As a preparation for this study the best obtainable general education is considered necessary; only people who have gone through the full nine years' course at a Gymnasium, Realgymnasium or Oberrealschule and have gained at the end the certificate of maturity by passing that well known, rather severe, Arbiturienten-Examen are admitted as students. People without that certificate can get permission to study as "Hospitants" but the fees are higher for them and they are not admitted to any examinations and can of course not take degrees. The newest regulations exclude Hospitants who are not in possession of the "one year's service certificate," *i.e.*, have not passed that particular examination after a six years' course at a secondary school.

Every student who wants to take degrees must have had at least one year's workshop practice before his first academical examination. This new clause was not introduced until an enquiry had been made as to the readiness of industrial establishments to accept volunteers in their works. 520 engine-works, shipyards, electrical works ironworks, foundries, bridge building firms, etc., have now agreed and about 1,750 places are available every year, in addition to those provided by the State for training its railway engineers. For this latter group the regulation is, that the State-Railway Engineer Students work six months in the fitting shop and two months each in the machine shops, foundry and pattern shops; they have to keep an account of their work and being *Volontäre* receive of course no remuneration.

The object of the workshop practice is not to teach the future student any handicraft as such, but merely to make him ac-

quainted with the materials, tools, and working methods, and last but not least with the workmen, the purpose is to give him an idea about the conditions, means and limits of manufacture and workmanship.

Having passed all these stages of preparatory training the youth will be freely accepted at any German Hochschule on account of his certificates and without further examination; entrance examinations do not exist either at the universities or at the Hochschulen.

As a student he enjoys an almost perfect freedom; he may take his apartments and use his time as he likes, he is not even compelled to attend the lectures, and no control is exercised by examinations, etc., during the session.

This "Academical Freedom" is considered essential for the individual evolution of the mind. However dangerous it may become sometimes, nobody who has once been a German student and enjoyed the charm of that freedom would ever admit it being in any way curtailed.

This freedom exists in the teaching as well as in learning. The Professors are independent in expressing their thoughts and only responsible to science itself. Socially they are standing directly under the Minister of Education, who appoints them and often fixes their salary with them privately. The salary consists in a fixed annual sum plus the student's class fees. Besides these ordinary Professors there are generally a number of qualified private teachers (Privat-Dorenten) lecturing either on the same or on special subjects, they have no fixed salary, but receive as a rule the whole tuition fees paid by their students for their lectures or at least a part of them.

The instruction at the Hochschule is for the first year chiefly general in character, later on specialization into the different branches of engineering takes place. To suit this arrangement the Hochschule contains different sections (Abteilungen) and every student is entered into one of them. At Charlottenburg for instance there are six sections:—

1. Architecture
2. Civil engineering.
3. Mechanical engineering.
4. Naval architecture.
5. Chemistry and Metallurgy
6. General sciences.

Every student belongs for the first year to Section 6. Although free in his choice, he is recommended to follow a certain course of studies laid down in a programme for the different sections, he may also obtain advice in this direction from the *Abteilungsvorsteher* of that section, a professor detailed for this special duty every year. The method of forming a separate section for the students of the first year, originally copied from the French "école polytechnique" has become more and more a matter of form; and the programme of study for the first year, *i.e.*, the subjects recommended are no longer quite uniform for the different branches of engineering.

As an example the course of study for mechanical engineering, *i.e.*, Section 3 at Charlottenburg, is given in Appendix V. (pp. 34-38); the list contains 116 classes arranged according to their relative importance. The great number of subjects obliges the student to specialize early.

For the training of the Hochschulen three parallel methods are in use; viz.: lectures, practical courses in drawing and designing, and experimental courses in laboratories.

The lectures are held in the usual way; the students make their notes while the professor is speaking and explaining. Some of the lectures are public, *i.e.*, free of charge, while the first three lectures in every subject are as a rule also free in order that students may form an opinion before entering the class. Libraries, models, art collections, etc., give every student an easy opportunity to widen and deepen the knowledge acquired in the lecture rooms; for the same purpose a number of excursions are made every year.

The instruction by lectures has to go hand in hand with the courses of drawing and designing. The latter bear at first a general character and extend for instance over ornamental drawing, geometrical drawing, graphical statics, etc. After these, follow more specialized designs, at first of details and later of whole constructions. The rooms provided for drawing and designing are open to the student all day from 8 a.m. to 8 p.m., he may divide his time as it suits him, but assistance is only given at the particular hours appointed for the courses.

The training itself tends to an individual development of each student; the object is to educate him to self dependence and self-reliance. The help of the Professor and his assistants is gener-

ally confined to suggestions and criticisms concerning the most practicable way of designing the leading principles for the design and the application of the details; the student is supposed to learn not only what is general practice but also why it is general practice. He must even find his way if his practicl experience fails, as for instance when he finds himself confronted with the task of designing an engine, of which he has never seen an example in practice.

Similar principles apply to the laboratory courses, which are intended to develop the student's faculties of observation. The great value of laboratories for technical education is fully recognised and much has been done lately for their development, especially for mechanical engineering. Large and well equipped laboratories have been established in several places during the last five or ten years. Formerly we had only laboratories for chemistry, physics, and electricity, but at present, kindred institutions are in existence for mechanical engineering, technology, electro-chemistry, metallurgy and other subjects. This variety and specialization is further extended inside of the different laboratories so that each student may train his abilities in any direction which suits his particular taste and inclination.

He has, however, to consider what is demanded for the examinations; and he has to arrange his wishes and lectures accordingly; but even here reforms have taken place recently allowing more specialization than before.

Examinations are not compulsory, unless the student wants to obtain a certificate and take a degree. Since the degrees of "Dipl. Ing." and "Dr. Ing." have been attached to the examination of the Hochschule known by the name of "Diplom Examen" it is more generally recognized and appreciated.

Even the Prussian State has recently adopted it for the technical government officials.

The first examination at a Hochschule can not be passed until after 2 years of study; it contains mainly general subjects as laid down in the programme for that period. Before the admission is granted to this preliminary examen the drawings of the student completed during the 2 years have to be found satisfactory. After passing in all subjects the student has again two years' time for preparing himself for the second and principal examination. In applying he has to hand in a certain number

of designs and solutions of experimental problems; if these are found satisfactory he will receive a greater constructional or experimental task and has three months' time for its solution. All drawings sketches, calculations, etc., have to be delivered after that period together with a description including the leading considerations for the solution of the task. When the solution is passed by the authorities, the candidate is advised of the time of his oral examination which has to be passed in all the subjects determined for his special line. If the student does not succeed the first time he is only allowed one other trial after at least one session. By passing the candidate becomes a "Dipl. Ing." or "Diplom-Ingenieur" a title which qualifies him as a scientifically trained engineer with a complete Hochschule education.

The next step, viz., the "Dr. Ing." (Dr. Ingenieur) may be taken by producing a scientific paper, based on private research. As far as I know there is a tendency among the authorities to simplify forms, and to combine later on, if possible, both examinations for the Dipl. Ing. and Dr. Ing. into one, in order to save as much as possible of the students' time and energy.

But in any case the course will not be finished before the student's 25th year. The general education commences at the 6th year, and if the pupil is exceptionally successful every year, it may be completed or rather the "Abiturienten Examen" (examination of maturity) may be passed after 12 years, *i.e.*, at the 18th year of age. One year in the workshop and one year's service in the army is the minimum practice and makes the youth twenty, the study at a Hochschule requires at least four years to which, it is advisable to add one year for examinations.

The total expenditure of such a course may be calculated as follows:—twelve years secondary school, each year requiring as an average £6 for tuition fees, £4 for books, and if the parents are not living in the same place about £25 to £40 for board and lodging; that is altogether for twelve years £420 to £600. One year's workshop practice will take about £40 to £50 for living expenses and the year in the army will cost at a minimum about £70 to £100. Each subsequent year at the technical college or Hochschule requires about £12 for tuition and say £50 to £70 for living and general expenses, being altogether £310 to £410 for five years. The total sum for a complete technical education of the highest standard in Germany is thus about £840 to £1,160.

After leaving college the academical engineer will generally find a situation. Engineers with Hochschule education are in fairly good demand, especially those who have taken degrees. They will at first earn a salary of about £5 to £8 a month which will sooner or later be increased according to their abilities, and many of them after 3 or 4 years' practice arrive at £200 to £300 a year and more.

All this however only applies to men who are ready to fight their own way, *i.e.*, to take an occupation in private practice. Academical engineers who seek shelter under the wings of the Government as State railway engineers, dockyard officials, etc., have to serve several years longer without remuneration and seldom receive any pay before they are 28 to 32 years old.

The attendance of the German Hochschulen has increased rapidly during the last ten years, and is still increasing although at a more moderate rate.

A general list shewing the different Hochschulen and the number of their students, etc., is given in Appendix VI. (p. 39). Not included in this list are the Hochschulen with German instruction existing outside of Germany, principally in Austria and Switzerland.

The influence of the great number of scientific engineers sent into practice by the German Hochschulen during their comparatively short existence is becoming more and more appreciable. The general understanding about the immense importance of scientific working is gaining ground every day. German engineers are confident that many of the difficult questions and problems, occurring in practice, can only be solved by scientific investigation and experiment. Therefore a fund of nearly £100,000 has been raised by subscription in industrial circles for the purpose of supplying the means for scientific research, to attack problems of general technical interest and practical importance.

APPENDIX I.

PROGRAMME OF TEACHING FOR A GYMNASIUM (1901-2), GIVING THE DIFFERENT SUBJECTS AND THEIR WEEKLY HOURS.

No.	Subjects.	Preparatory Classes (Vorschule). 3rd Class.	2nd Class.	1st Class.	Total Hours
1	Religion	2	2	2	6
2	German	10	6	6	22
3	Arithmetic	4	4	5	13
4	Object Lessons	—	2	2	4
5	Writing	—	2	4	6
6	Singing	—	2	2	4
7	Gymnastics	—	1	1	2
	Total hours per week ...	16	19	22	57

No.	Subjects.	Gymnasium Classes. VI.	V.	IV.	IIIB.	IIIA.	IIB.	IIA.	IB.	IA.	Total Hours.
1	Religion	3	2	2	2	2	2	2	2	2	9
2	German, etc.	4	3	3	2	2	3	3	3	3	26
3	Latin	8	8	8	8	8	7	7	7	7	28
4	Greek	—	—	—	6	6	6	6	6	6	36
5	French	—	—	4	2	2	3	3	3	3	20
6	History	—	—	2	2	2	2	3	3	3	7
7	Geography	2	2	2	1	1	1	—	—	—	9
8	Arithmetic & Mathematics	4	4	4	3	3	4	4	4	4	34
9	Natural Sciences	2	2	2	2	2	2	2	2	2	18
10	Writing	2	2	—	—	—	—	—	—	—	4
11	Drawing	—	2	2	2	2	—	—	—	—	8
	Total hours per week ...	25	25	29	30	30	30	30	30	30	259

NOTE.—The braces ⌢⌣ mean that the two subjects may be temporarily exchanged.

To the above hours have to be added: as obligatory, 3 hours for gymnastics through all classes, and 2 hours for singing for VI. and V. The pupils from IV. upwards, if capable, are obliged to sing in the choir; *as optional*, 2 hours for drawing, beginning with IIB.; 2 hours for English and 2 hours for Hebrew, beginning with IIA.

APPENDIX II.

PROGRAMME OF TEACHING FOR A REALGYMNASIUM (1900-1), GIVING THE DIFFERENT SUBJECTS AND THEIR WEEKLY HOURS.

No.	Subjects.	Classes. VI.	V.	IV.	IIIB.	IIIA.	IIB.	IIA.	IB.	IA.	Total Hours.
1	Religion	3	2	2	2	2	2	2	2	2	19
2	German, etc.	4	3	3	3	3	3	3	3	3	28
3	Latin	8	8	7	4	4	4	4	4	4	47
4	French	—	—	5	5	5	4	4	4	4	31
5	English	—	—	—	3	3	3	3	3	3	18
6	History and Geography	2	2	4	4	4	3	3	3	3	28
7	Arithmetic & Mathematics	4	4	4	5	5	5	5	5	5	42
8	Natural History	2	2	2	2	2	2	—	—	—	12
9	Physics	—	—	—	—	—	3	3	3	3	12
10	Chemistry & Mineralogy	—	—	—	—	—	—	2	2	2	6
11	Writing	2	2	—	—	—	—	—	—	—	4
12	Drawing	—	2	2	2	2	2	2	2	2	16
	Total hours per week	25	25	29	30	30	31	31	31	31	263

NOTE.—*To the above hours have to be added:* gymnastics, 3 hours through all classes; singing, 2 hours through all classes.

APPENDIX III.

PROGRAMME OF TEACHING FOR AN OBERREALSCHULE (1901-2), GIVING THE DIFFERENT SUBJECTS AND THEIR WEEKLY HOURS.

No.	Subject of Teaching.	Preparatory Classes (Vorschule). 3rd Class.	2nd Class.	1st Class.	Total.
1	Religion	2	2	2	6
2	German	5	6	8	19
3	Arithmetic	4	4	4	12
4	Object Lessons	2	2	2	6
5	Writing	4	4	4	12
6	Singing	1	1	1	3
	Total hours per week	18	19	21	58

APPENDIX III.—(*Continued*).

No.	Subjects	Obberealschule Classes. VI.	V.	IV.	IIIB.	IIIA.	IIB.	IIA.	IB.	IA.	Total Hours.
1	Religion	3	2	2	2	2	2	2	2	2	19
2	German, etc.	5	4	4	3	3	3	4	4	4	34
3	French	6	6	6	6	6	5	4	4	4	47
4	English	—	—	—	5	4	4	4	4	4	25
5	History	—	—	3	2	2	2	3	3	3	18
6	Geography	2	2	2	2	2	1	1	1	1	14
7	Arithmetic & Mathematics	5	5	6	6	5	5	5	5	5	47
8	Natural History	2	2	2	2	2	2	—	—	—	12
9	Physics	—	—	—	—	2	2	3	3	3	13
10	Chemistry and Mineralogy	—	—	—	—	—	2	3	3	3	11
11	Writing	2	2	2	—	—	—	—	—	—	6
12	Drawing	—	2	2	2	2	2	2	2	2	16
	To the above have to be added:										
13	Singing	2	2	1	1	1	1	1	1	1	11
14	Gymnastics and Games	3	3	3	3	3	3	3	3	3	27
15	Geometry Drawing (*opt.*)	—	—	—	—	2	2	2	2	2	10
30	Total hours per week ...	30	30	33	34	36	36	37	37	37	310

APPENDIX IV.

TECHNICAL MIDDLE SCHOOLS IN PRUSSIA (1901-2), AND THEIR STATE SUBSIDIES.

(£1 = 20 marks appr.)

Name.	No of Teachers.	Total Yearly Expenditure.	Amount granted Yearly by State.
(*a*) *State Institutions:*—			
Dortmund: Höhere Maschinenbauschule und Maschinenbauschule (Werkmeisterschule)...	23 and 1 Werkmeister	£ 8,649	£ 6,429
Elberfeld-Barmen: do.	15 and 1 W.	4,587	2,643
Stettin*: Höhere Maschinenbauschule ...	6	1,998	892
Breslau: do. ...	11	3,747	2,266
Hagen: do. ...	16	5,088	3,190
Posen: do. ...	5	1,316	1,043
Einbeck: do. ..	8	2,659	1,874
Altona: do. ...	9	3,040	2,183
(*b*) *Municipal Institutions:*—			
Cöln (Cologne): Höhere Maschinenbauschule and Werkmeisterschule ..	16	4,732	1,628
Total	109 and 2 W.	35,816	22,148

* For equipping the School at Stettin with appliances for teaching, engines and implements, an additional sum of £3,800 was granted in 1901 by the State.

			Sat. 2 hours (between 3 & 7)		U.	Versuchs-Anstalt	Sat. 2 hours (between 3 & 7)		U.	Versuchs-Anstalt.
13	Graphical statics	Jolles	W.	10-12	V.	221	—		—	—
			W.	12-2	U.	122-123	—		—	—
		Kötter	W.	10-12	V.	221	—		—	—
			W.	12-2	U.	122-123			—	—
14	Water motors	Reichel	Fr.	5-6	V.	E.B. 165	Sat.	5-10	V.	E.B. 165
24	Engine Laboratory Course II.	Josse	6 hours, by private agreement		U.	Engine laboratory	6 hours, by private agreement		U.	Engine laboratory
25	Machines (Arbeitsmaschinen)	Riedler	Mo.	10-12	V.	241	—		—	-
26	Designing of Machines	Stumpf	Th.	2-6	U.	146 and 149-151	Tu.	2-6	U.	146 and 149-151
27	Statics of Constructions	Miller-Breslau	Th.	10-12	V.	358	Th.	10-12	V.	358
28	Elements of Architecture, Civil Engineering, etc.	N.N.	Fr.	8-10	V.	241	Sat.	8-10	V.	E.B. 165
			Th.	8-12	U.	146 and 149-151	Mo.	2-6	U.	146 and 149-151
29	Metallurgy of Iron, I. & II.	H. Wedding ..	Th.	6-8	V.	259	Th.	6-8	V.	259
30	Science of Financing	Paasche ..	Th.	6-8	V.	119	Th.	6-8	V.	119
31	Bank and Exchange Transactions ...	Warschauer ...	Mo.	6-7	V.	120	Mo.	6-7	V.	120
			W.	5-6	,.	233				
32	Exercises on Bank and Commercial Transactions	Warschauer ..	Sat.	5-7	U.	119	—		—	

APPENDIX V.—(*Continued.*)

In addition to the foregoing, the following subjects may be included in the programme of the first six sessions (No. 33-52):—

1ST YEAR'S COURSE.

						,,	259	W.	4-6	V.	259
46	Principles of Railway Water and Road Building	Dietrich ...	Fr. Sat.	4-6 2-4	,, ,,	359 ,,	Fr. Sat.	4-6 2-4	,, ,,	359 ,,
47	Kinemat. Geometry and Kinematics ...	W. Hartmann ...	Tu.	4-6	,,	259	Tu.	4-6	,,	259
48	Special Chapters on Applied Kinematics	W. Hartmann ...	W.	10½-12½	,,	259	W.	10½-12½	,,	259
49	Theory of the Curves and Surfaces in the Space	Hettner ...	Fr.	10-11	,,	233	Fr.	10-11	,,	233
50	Industrial Hygiene (Prevention of Accidents)	K. Hartmann ...	Tu. Fr.	10-12 9-10	,, ,,	234 159		—	—	—

ALSO IN THE 1ST TO 4TH YEAR'S COURSE.

51	French Literature	Gropp	W.	6-8	V.U.	119	W.	6-8	V.U.	119
52	English	N.N.	Tu.	4-6	,,	261	Tu.	4-6	,,	261
	(*a*) Elementary Course ...		Fr.	4-6	,,	,,	Fr.	4-6	,,	,,
	(*b*) Advanced Course ...		Tu.	6-7	,,	,,	Tu.	6-7	,,	,,
			Fr	6-7	,,	,,	Fr.	6-7	,,	,,

APPENDIX V. —(*Continued.*)

After the 3rd Year's Course, opportunity is given for further development by the following subjects for:—

72	Design of Electrical Establishments ...	Klingenberg ...	Fr. 5-7 Th. 2-5	V. U.	141 250	Fr. 5-7 Th. 2-5	,, U.	,, 250
73	Construction and Working of Gas Engines	Klingenberg ...	Fr. 8-10	V.	141	2 hours, by private agreement	,,	,,
74	Construction and Working of Automobile Vehicles	Klingenberg ...	... ...	...	... ...	Fr. 8-10	V.	141
75	Dynamical Theory of the Steam Engine	W. Hartmann ...	Tu. 8-10	V.	159	—	—	—
76	Survey of Shipbuilding	Flamm	Sat. 8-10	,,	233	—	—	—
77	Marine Boilers	N.N.	Th. 10-12	,,	234	W. 12-2	,,	,,
78	Marine Engines, I.	N.N.	Tu. 8-10 Fr. 8-10	,, ,,	,, ,,	Tu. 12-2 Fr. 12-2	V. ,,	., ,,
79	Auxiliary Machinery for Ships	N.N.	... ...	...	... ...	W. 10-12	,,	234
80	Chemical Technology, I.	Witt	... ...	...	... ...	W. 8-10 Fr. 8-10	,, ,,	Lab. 203 ,,
81	Mining	Weeren	Mo. 8-10 Fr. 8-10	V. ,,	Lab. 245 ,,	—	—	—
82	Foundries	Weeren	Th. 4-5	V.	,.	—	—	—
83	Water Supply and Drainage of Towns ...	Büsing	Mo. 5-7	,,	359	Mo. 5-7	V.	359
84	Movable Bridges	Bernhard ...	Mo. 4-5	,,	,,	Mo. 4-5	,,	359

(b) Mechanical Engineering (Railways).

No.	Subject.	Teacher.	Winter Session. Time.		Winter Session. Room.	Summer Session. Time.		Summer Session. Room.
85	Construction of Railway Machinery, especially Locomotives, etc.	N.N.	Tu. 10-12 Fr. 11-1 Tu. 2-6	V. ,, U.	259 241 248	Tu. 10-12 W. 4-6 Tu. 2-6	V. ,, U.	259 ,, 248
66	Heating and Ventilation							
67	Laboratory for Heat Technics							
76	Survey of Shipbuilding							
91	Railway Stations	Goering ...	Th. 8-10	V.	358	Th. 8-10	V.	358
92	Railway Constructions	Goering ...	Tu. 8-10 Th. 11-1 Fr. 8-10	,, ,, ,,	359 ,, ,,	Tu. 8-10 Th. 11-1 Fr. 8-10	,, ,, ,,	359 ,, ,,
71	Electrical Railways	Subjects mentioned before						
81	Mining							
82	Foundries							
80	Chemical Technology I.							
93	Foundations	Bubendey ...	W. 8-10 Fr. 8-9	,, ,,	358 ,,	— —	— —	— —
94	Practical Hydraulics	Bubendey ...	Fr. 9-10	,,	,,	—	—	—
95	Locks and Canal Building	Bubendey ...	— —	— —	— —	W. 8-10 Fr. 8-10	V. ,,	358 ,,
83	Water Supply and Drainage of Towns ...	Subjects mentioned before						
84	Movable Bridges							

APPENDIX V.—(*Continued.*)

(c) Electricity.

			Winter Session.			Summer Session.		
56	Industrial Hygiene							
58	Special Mechanical Technology	Subjects mentioned before						
86	The Working of Railways, etc.							
87	The Working of Railways, etc.							
62	Industrial Establishments							
63	Communal Establishments							
107	The Physical Foundations of Electro-technics I. and II.	Kalischer ...	W. 10-12	V.	261	Mo. 10-12	V.	261
108	Elements of Electro-chemistry	Kalischer ...	—	—	—	Th. 10-12	,,	159
109	General Electro-chemistry	von Knorre ...	—	—	—	W. 10-12	,,	,,
			—	—	—	Th. 4-6	,,	,,
110	Applied Electro-chemistry	von Knorre ...	—	—	—	W. 10-12	,,	,,
			—	—	—	Th. 4-6	,,	,,
111	Magnetism and Electrical Units, etc. ..	Grunmach ...	2 hours, by private agreement	V.	Physical Hörsaal	2 hours, by private agreement	,,	Physical Hörsaal.
112	Electro-magnetism and Induction ...	Kalischer ...	—	—	—	Tu. 12-2	,,	261
			—	—	—	Sat. 11-	,,	,,
113	Theory of Galvanism	Gross	2 hours, by private agreement	V.	—	2 hours, by private agreement	,,	—
114	Introduction into the Theory of Potentials	Gross	2 hours, by private agreement	,,	—	2 hours, by private agreement	,,	—
115	Elements of the Theory of Potentials and their Application	Kalischer ...	Tu. 10-12	,,	261	—	—	—
116	Electrical Vibrations	Kalischer ...	Sat. 12-1	,,	261	—	—	—

APPENDIX VI.

The Technical Hochschulen of the German Empire in the Winter Session, 1902-3.

Name of Hochschule.	Aachen.		Berlin.		Braunschweig.		Darmstadt.		Dresden.		Hanover.		Karlsruhe.		München.			Stuttgart.		Total number of Attenders.			
Students and Hospitants for Section.	St.	H.	St.	H.	St.	H.	St.	H.	St.	H.	St.	H.	St.	H.	St.	H.	H.	St.	H.	W.S. 1902-3.	W.S. 1901-2.	Increase in No.	Increase
Architecture	60	24	477	262	37	8	137	100	113	42	147	115	285	34	341	72	24	217	—	2496	2462	34	1·4
Civil Engineer. (Bauing)	68	6	647	42	74	8	217	24	278	18	309	29	251	12	710	14	6	219	—	2932	2670	262	9·8
Mechanical Engineering	104	35	1319	180	124	94	452	115	359	66	544	101	488	30	1027	60	14	36	—	7119	7221	- 102	- 1·4
Electrical Engineering	75	17	270	51			516	92			208	50	344	23						382	371	11	3
Naval Architecture	—	—	347	35	—	—	—	—	—	—	—	—	—	—	—	—	—						
Chemistry	46	13	161	20	60	15	134	17	157	15	80	15	196	24	145	—	18						
Metallurgy	126	27	169	11	—	—	—	—	—	—	—	—			—		—			1762	1653	109	6·6
Pharmacy					50	1	16	—	—	—	—	—			—		—						
Mining	110	14	—	—	—	—	—	—	—	—	—	—			—		—						
Forestry	—		—		—	—	—	—	—		—	—	30		—		—			31	24	7	29
Agriculture	—	—	—		—		—	—	—		—	—			46	0	9	—		65	56	9	16
Mathematics and Natural Sciences	—		—				—	—	—	—	—		7	2	—	—		28		629	560	69	12·3
General Sciences and Arts	5	2	6	—		40*	34	5	27	21	4				150	28	258	12	—				
Commercial Sciences	112	55*	—	—			—	—	—	—	—	—	—	—	—	—	—	—	—	167	—	167	—
Belonging to no section	—	22*	—	381*		—	—	89*	—	183*	—	416*	—	138*	—	—	—	—	226	1455	1333	122	9·1
Total	606	215	3396	982	345	166	1506	442	934	345	1292	726	1602	264	2419	195	329	948	226	...	...	...	...
Grand Total	821		4378		511		1948		1279		2018		1866		2943			1174		16938	16350	588	3·6

Hospitants are meant persons attending lectures who are not in possession of the certificate required for full studentship, and who consequently cannot sit at Examinations. Some of them attend a full course of study; others, marked *, only attend a few special lectures.

DISCUSSION.

The PRESIDENT—I am sure we are all much obliged to Mr. Wurl for his able paper. Mr. Griffith, whom I see present, has devoted some time to the study of educational methods; may I call upon him to open the discussion, which, I hope, will be a thorough one.

Mr. E. GRIFFITH said—I feel that in asking me to open this discussion the Council has placed me in rather a difficult position. I should have liked to have compared this German system of education and training with our own, and, after a searching analysis, to point out how superior our methods are. But of course I am not able to do that. I am therefore obliged to seek some other course, and what I propose doing is to point out what I think may be an improved method for ourselves as compared with what we have, and in that way incidentally to consider in what respect we should copy our German friends, and on what points we should avoid their example. I think that in most essentials the system which we have had described so fully is an excellent one. But in one or two features, as will come out further on in my remarks, it appears to me defective. As we have to consider what improvements are desirable in our own country, the first point I would emphasize is that we should distinguish between the training necessary for a mechanic and for an engineer—that is, for a man who has to make a living by a handicraft, and a man who has to make his living by one of the most highly intellectual professions of the present day. Obviously the training for the one is not sufficient for the other, and I regard it as absolutely necessary to make a clear, definite, and unequivocal distinction between the two. Perhaps I should remark that I use the word engineering in its broad sense here. It includes naval architecture and other structural work of an engineering character. A great many engineers have not fully realised the distinction referred to and hardly any of the general public. If we read the remarks of local dignitaries, for example, who largely control education here, we find their idea of our requirements would be to establish institutions to teach handicrafts. That is not what we

need. I think the handicraftsmen of our country are as capable as any and their proper training place is the workshop, and my remarks do not apply to that branch of the subject.

The next feature is that a sound, general, secondary education is necessary before starting the special technical education at all. In England we have no organized system of secondary education, which I think is almost a disgrace to this country. Wales has been more enterprising, and since the passing of The Welsh Intermediate Education Act in 1889, secondary education in Wales is excellent in its framework, and might well serve as an inspiration and example for England and Scotland. I think that the secondary education of an engineer ought to be quite modern, that is, useful, and should include all that is necessary to make a good citizen. It should consist of such subjects as mathematics, mechanics, history—history in the broad sense, not mere dates, the history not only of this country, but other countries, ancient and modern, and geography, political economy, the principles of trade and commerce, and modern languages, such as French and German. Languages ought to be learned when quite young. Nature indicates that. It is at our mother's knee we learn our language. We ought to take a hint and not waste time later on in learning languages in an uninteresting way. I should make it absolutely essential that a student should pass a thorough examination in secondary education before being admitted to a technical college. I should not have time wasted in a college on secondary education, no matter what the social standing of the student may be. I would not sacrifice the efficiency of education in the supposed interest or convenience of either the rich or the poor. The State should make it its business to find and to properly train the best talent of the nation, whatever its rank may be.

My next point is, a secondary and technical education should have a large measure of State aid and regulation. It will not pay in the narrow and immediate sense, although the best investment possible in its ultimate results. So that you will never get an efficient system of higher education except with considerable assistance from the State. It is a case of "cast thy bread upon the waters," and it is the duty of any nation that aims at being one of the great nations to treat the higher education of its children

in no niggardly spirit. State influence has many other advantages. It ensures uniformity, it provides a system of tests and examinations, which are common throughout the country. We now come to technical education, and I think that a Central Permanent Committee representing Engineering institutions is required to advise and guide the State Education Department regarding both the secondary and technical education necessary for engineers, and such a committee should be associated with local committees to do similar work for local educational authorities. Technical colleges should be given the same dignity as the ancient Universities, which are certainly not of more importance in a modern State. I think the best way is to have a technical section in a general University, as mutual intercourse will benefit all those engaged in the various branches of learning, both the professors and the students.

I see that in Germany this method has not been practicable because of the obstruction of the older seats of learning. College professors ought to have a large measure of personal freedom, but their responsibility should be made as real as possible, and enforced; and I think an effort should be made to supplement the work of the professors by lectures from suitable practising engineers, as is now done in naval colleges to some extent.

I doubt whether the freedom accorded to the students in Germany would be a wise thing here—I mean the degree of freedom that has been referred to by Mr. Wurl. It may be suitable for the Teutonic character and mind. I do not think it would be for the British. I doubt whether that go-as-you-please policy would lead to as good results here as if you made it more immediately necessary for the students to apply themselves to their work.

Engineering laboratories should be used to illustrate principles chiefly, and to develop the faculty of observation, and not to teach handicrafts. The main function of the colleges should be to give the students a thorough grasp of the principles of engineering and mechanics.

The next point—and here I come to a distinct difference between what I think we should aim at, and what is customary in Germany—is that under normal conditions a youth ought to finish his secondary education when seventeen years of age,

and his engineering education and apprenticeship at 22. He should then be required to pass a test of efficiency imposed or sanctioned by the State. The five years between 17 and 22 should be spent partly at college and partly at workshops; preferably, six months yearly at each. By that time he ought to be able to earn his living. I think it a weak point in Germany that when a man reaches 25 he has only been one year doing practical work under the higher educational system there. Then I would suggest that within a reasonable period after the establishment of a systematic course of training for engineers no unqualified person should be allowed to practice engineering in any professional or executive capacity.

I quite grant that all this cannot be introduced immediately and that it must be done gradually. Still, it seems proper to have a definite final aim in view, so that we may be sure when moving that we move in the right direction. I am aware it will take a great effort to reach a complete system and I think the first work to do is to convince the majority of engineers of the necessity of such a thing. Personally, I feel strongly it is not a day too soon to do all we can to establish some such system as I have outlined and I feel we are very much indebted to Mr. Wurl for bringing the subject before us in this form, and letting us know what is doing in Germany.

Professor R. L. WEIGHTON said—I am pleased to have the opportunity of complimenting Mr. Wurl on the excellence of his paper. Though he is a foreigner, and necessarily not conversant from his infancy with our language, I think you will agree with me that he has not only produced a very readable paper, but he has given us a great many very suggestive thoughts, in addition to the facts so well expressed. I therefore feel that he deserves to be complimented in the first place. This paper is on a subject which I think everyone will agree is most appropriate at the present juncture in the history of this country. We are in this country just about setting our house in order educationally, especially with regard to technical education, and therefore it is desirable that we should know what our competitors have done in the past and are likely to do in the future. That raises the question as to what we can learn from the system at present in vogue in such a country

as Germany. We naturally set ourselves to ask what we can take from their system and adopt in ours. In connection with this the first thought that occurs to one is that we do not necessarily require to merely copy. We must develop along our own lines, educationally and otherwise. At the same time that does not prevent us attempting to find out whatever may be in it which suits us. We learn from the man across the street no less than from the nation across the water. So this is a very practical question: What can we adopt from this, and what limits can we get to help us in our own system, or, as Mr. Griffith put it, want of system? There has occurred to me one or two points in connection with the system in Germany, and the first one which very forcibly strikes one in my position is this—that the system which obtains in Germany is immensely specialised, and sub-divided, and generally provided for, as compared with what obtains in our own country. To give an illustration which is obvious to anyone who reads this paper — I have counted in the lists of subjects here, no fewer than fifteen teachers in mechanical engineering alone in Charlottenburg. I do not know how many of these are of the rank of professors, and how many simply lecturers, but there they are, fifteen for mechanical engineering alone! I in my unworthy self represent, along with one assistant, mechanical engineering in the University College of the North-East coast, and I not only represent that, but, with another assistant, naval architecture and civil engineering as well. That is an old story, and the professors and teachers in engineering, as well as those conversant with our technical educational system in the higher ranks, are aware, when compared with other nations, and especially with Germany, we are simply nowhere as regards specialization in teaching. The first lesson we can learn is that we have got to specialize a great deal before we can touch Germany, not to speak of America. The question naturally arises, what is the cause of this? In one word, the cause of it is want of means. And this again is because we have no national system of higher education. We have got a national system—some of us think we have—for elementary education; some of us are a little doubtful of it. There are none of us doubtful at all as to whether we have a national system of *higher* education, particularly in the tech-

nical sphere. We have none. The higher technical instruction is left to haphazard and voluntary contribution. In America it is left in the same way, but fortunately for Americans they produce a race of millionaires over there. We do not seem to do that at all—at any rate not millionaires who make a hobby of technical education. It is a graded system, an organised system, which the Germans have got. I confess that as a nation—and I rank ourselves with the Americans in this respect—we do not excel in organization. We see it in the educational sphere, as well as in the way we conduct our wars. The Germans appear to me to be specially adapted by nature for organizing. The next noticeable point is the immense numbers that attend the classes in this specialized education. There is a list given on the last page of the paper shewing the number attending the technical Universities alone. These numbers are perfectly astounding to every one of us in this country. The numbers in this country cannot compare with them for a moment. The third point, and it is a very important one, is referred to in one paragraph of the paper, namely, that when a student in Germany has gone through this long course of specialised study, which means a great deal of hard work, and a great deal of self-denial, he then finds no difficulty in getting suitable employment at a remunerative or at least at a living, wage. That is a very, very significant fact. It is the same in America. These two countries have at last reached this stage in their technical development as regards education, that they thoroughly realise—both employers and employed—an indispensable value of higher education. Contrast our own country. Till recently it was in some senses a positive disadvantage and disqualification to have a university training in engineering. I say this advisedly, as I have come through it. We are now getting beyond that, I am happy to say, and a great deal of the credit of it is due to men like Mr. Yarrow and our President. This feeling is spreading amongst those who have the power of either accelerating or retarding progress in technical education of the higher quality, namely, the employers. The German employers seem to have learned its value. This third point appears to me to be related to the second point as cause is to effect. I think the numbers attending these German classes are very likely due to the fact that

there is a demand for an University training amongst those who employ engineers. In this country I think the paucity of the numbers obtaining higher education in technical science is due to the comparative want of that demand hitherto. It is very pleasing for one to be able to reflect that this very undesirable state of matters, namely, the absence of encouragement to young men to thoroughly qualify themselves educationally, is gradually being changed. At this particular moment in this country there is a very vigorous agitation or movement on foot, the object of which is to overcome this prejudice which has hitherto existed with regard to a higher education for engineers, and the only question on which one feels doubtful in the matter, is how soon, or how long, will it be before we overtake our competitors? It is an urgent matter. There is no doubt about that, I think. Brain power is one of the most indispensable resources of a nation. There are others, certainly. There are the material resources of a nation. But its wealth resides not alone in its material, but also in its mental resources. This country has hitherto worked its material resources very successfully. It is, let us hope, beginning to work as well its mental resources, the brain of its people, by developing them educationally to the fullest possible extent, and when that is done thoroughly then we may hope to be able, and I have no doubt will be able, to hold our own with our competitors.

Mr. JOHN H. HECK said—I have listened with much pleasure to Mr. Wurl to-night. We could not have any better practical illustration of the value and thoroughness of German education than the fact that Mr. Wurl has read his paper in such good English and giving us so interesting a description of the German school and academic system. Some of us have been in German schools years ago, but it is doubtful whether there are many members who could compose or read so clearly in German a similar paper before any of the learned societies in Berlin or other German town.

There is no doubt the value of education is great. German students are good and it would be hard to find any better. English students are also good when they enjoy similar advantages. Durham College and kindred institutions are turning out a number of young men who will make their mark

in the future: the aptitude and bent of a boy himself is one factor but there is another one and that is, that facilities and assistance should be given to any youth in this country to get knowledge if he desires and earns it. Of all the education systems that we have none is better than that adopted by the Admiralty, viz., in having schools in the dockyards: this system has turned out quite a number of good and able men, and if such a system was employed in regard to apprentices of large shipbuilding and engineering establishments, it would do much good: in other words, Why should not a school and schoolmaster be a part of all manufacturing works, so that the boys and youths serving their time could at stated times or on certain days and evenings receive instruction: those who did best being eventually sent to some technical college for higher education? Boys who have to get up some time before 6 a.m., in order to get to the works by that time, work all day and do not return home until after 5 o'clock in the evening, when they have changed their clothing are, with few exceptions, not in the condition for hard study.

If some system similar to that in existence at the dockyards could be generally adopted, not only would it be to the benefit of the North-East Coast but to the country at large. Students would earn not only credit for themselves but also for their employers. Such a plan would pay and I think it is sure to come.

Mr. Wurl has read a very able paper and deserves the best thanks of the Institution.

The PRESIDENT said—It must give great satisfaction and pleasure to Mr. Wurl to find that his paper has been so well received, and that it has been the means of initiating what, I hope, will be a thorough discussion. I think it will be your pleasure that the discussion should be continued and I therefore adjourn it until our next meeting in this hall in December.

The meeting then dissolved.

MR. F. H. ALEXANDER'S REPLY TO THE DISCUSSION ON HIS PAPER ON "A DISPLACEMENT TABLE FOR USE WITH THE TCHEBYCHEFF FORMULA."*

NEWCASTLE-UPON-TYNE,
December 21*st*, 1903.

DEAR MR. DUCKITT,

I must express my regret at being unable to reply to the discussion on my paper read last Session, in time for such reply to be included in the *Transactions* in its proper place. However, I trust you will be able to find a place for it, if I send it now.

Referring to Mr. Heck's remarks, I am pleased to find that, although he criticised the method I put forward at the South Shields meeting, yet after careful testing he concluded that it gave very accurate results, quite equal to Simpson's method. I know that he spent considerable time and trouble in this testing, and his later statement is a valuable testimony for which I thank him.

Mr. Shaw's remarks were characterised by a thorough fairness, but there are one or two points wherein I differ from him. He appears to favour subdivided intervals at the ends of a plane in order to obtain greater accuracy with a given number of ordinates. Of course that is so, but it is just those subdivided intervals, with their fractional multipliers, that I have found in practice highly objectionable. In many cases I am sure that the work so introduced is greater than that saved by having fewer ordinates. Another point on which I do not at all agree with him is with regard to the use of Morrish's formula for the centre of buoyancy of the lower appendage. I find, on reference to that gentleman's paper published in the *Transactions of the Institution of Naval Architects*, 1892, that the maximum error, when dealing with volumes of this form, is about $\frac{1}{2}$ of 1 per cent. of the draft. Now the displacement of an appendage is only about $\frac{1}{8}$ of the light displacement of a cargo steamer of full form, and only about $\frac{1}{15}$ of her load displacement. So that the maximum error is reduced to $\frac{1}{8}$ or $\frac{1}{15}$ of $\frac{1}{2}$ per cent. of

* See pages 155, 166, and 177, vol. xix. of *Transactions of North East Coast Institution of Engineers and Shipbuilders*.

the draft of the appendage, and in a vessel of 25 feet load draft would only amount to about $\frac{1}{100}$ of an inch. Surely Mr. Shaw would not call this a serious error. Indeed on Mr. Laws's figures it is doubtful whether any practicable use of Simpson's rules would give us a truer result.

With regard to the saving of time, I doubt very much whether Mr. Shaw looked into the question beyond that required merely to find the area of a plane or the displacement volume of the vessel. On these points the saving of time is, I admit, very small, but surely it should be patent to any one that the arrangement of levers for finding the longitudinal position of the centres of gravity and buoyancy, and the longitudinal metacentre, must enormously reduce the labour and time. This is the special feature of the system, and it is curious that neither Mr. Shaw nor Mr. Laws thought it worthy of remark at all. I give on the next page comparative skeleton forms for my system and for Simpson's system, each having the same number of ordinates, but the latter having subdivided intervals at ends with wider spacing amidships. A glance at the multipliers used will shew wherein is the advantage I claim.

The time needed for the complete calculations was said to be $\frac{1}{2}$ to $\frac{1}{3}$ of that needed by the usual method; one shipbuilder tells me $\frac{1}{5}$ would be nearer the mark. My statement was based upon the work done by junior office hands, and not on my own work.

There is no difficulty in making launching or trim calculations as suggested by Mr. Shaw.

Turning to Mr. Laws's remarks, I must confess to being unable to understand the bearing they have upon the subject of the paper. I did not read a paper on the general subject of Mr. Tchebycheff's formula, though it now appears it might have been better policy to do so before going on to the application described in my paper. I did not and do not assume that the Tchebycheff 2-ordinate rule gives more accurate results than his rules having more ordinates: and I did not suggest using either Tchebycheff's rules or Simpson's rules in the way Mr. Laws has done in his examples. The results obtained by the integrator are likely to shew the greatest percentage of error when the extent of boundary of a figure is greatest in relation to its area: that is to say, the percentage is likely to

be much less in a square figure than in a long, very narrow rectangle of the same area, and Mr. Laws would surely hardly

Simpson.								Tchebycheff.					
No. of Station.	Ordinates.	Multipliers.	Functions of Ordinates.	Levers.	First Moments.	Levers.	Second Moments.	No. of Station.	Ordinates.	Levers.	First Moments.	Levers.	Second Moments.
0		$\frac{1}{2}$		8		8		1		5		5	
$\frac{1}{2}$		2		$7\frac{1}{2}$		$7\frac{1}{2}$		2		4		4	
1		1		7		7		3		4		4	
$1\frac{1}{2}$		2		$6\frac{1}{2}$		$6\frac{1}{2}$		4		3		3	
2		$1\frac{1}{2}$		6		6		5		3		3	
3		4		5		5		6		2		2	
4		2		4		4		7		2		2	
5		4		3		3		8		1		1	
6		2		2		2		9		1		1	
7		4		1		1		10		0		0	
8		2		0		0		11		0		0	
9		4		1		1		12		1		1	
10		2		2		2		13		1		1	
11		4		3		3		14		2		2	
12		2		4		4		15		2		2	
13		4		5		5		16		3		3	
14		$1\frac{1}{2}$		6		6		17		3		3	
$14\frac{1}{2}$		2		$6\frac{1}{2}$		$6\frac{1}{2}$		18		4		4	
15		1		7		7		19		4		4	
$15\frac{1}{2}$		2		$7\frac{1}{2}$		$7\frac{1}{2}$		20		5		5	
16		$\frac{1}{2}$		8		8							

expect us to accept the small error he gives as likely to apply to figures of all sizes and shapes. If the instrument is so absolutely reliable, why is it not used by shipbuilders in pre-

ference to laborious calculation from ordinates, for Mr. Shaw tells us that accuracy should not be sacrificed to time or labour saving? One firm on the Clyde, noted for its scientific work, does make use of the integrator for its preliminary calculations when designing the lines, but uses ordinates in making the final calculations from the finished lines.

As regards apparent errors in the longitudinal position of the centre of buoyancy or centre of gravity of waterplanes, it is to be noted that when the axis is chosen at the middle of length these errors (if of the same sign), being on opposite sides, will tend to neutralise each other, and so a more correct result be obtained than when an axis at one end is chosen. This point applies to Simpson's rules as well as to Tchebycheff's, and is worth the consideration of those who are accustomed to use the end axis. In addition there is a saving of figure work.

Mr. Laws calls attention to a possible error of some 60 tons in a ship of 6,000 tons displacement, if the Tchebycheff 9-ordinate rule were employed and compared with the 11-ordinate arrangement of Simpson's first rule. What has this to do with the case? I do not suggest the use of either rule. Mr. Laws may be surprised to hear that I have come across a case where there was a difference of 60 tons in a displacement of 6,000 tons, between two applications of Simpson's first rule. And I venture to say that a similar difference might be found between the calculations of two rival shipbuliders in this district if each calculated from a given body plan, but on their own displacement forms. The only real practical test is to take a displacement form such as is given in the paper, and one which is arranged on Simpson's system for an equivalent number of ordinates. On comparing the results, and the time taken, a just judgment can be made.

With regard to my statement that fine lines may be calculated with fewer ordinates than full ones, I ought to have said "equally-spaced" ordinates, when my meaning would have been clear.

In conclusion, I have to thank the Institution and those who took part in the discussion for the reception accorded to my first contribution.

Yours faithfully,

F. H. ALEXANDER.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

SECOND GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY EVENING, DECEMBER 18TH, 1903.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the first general meeting of the Session held in Newcastle-upon-Tyne on Friday evening, November 13th, 1903, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. J. H. Heck and Mr. R. Muir to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Beckett, W. H., Engineer Lieut. R.N., Controller's Department, The Admiralty, Whitehall, London, S.W.

Cumming, William Milligan, Engineer, Pape's Buildings, Pink Lane, Newcastle-upon-Tyne.

Easthope, James, Engineering Surveyor, Messrs. Lloyds Register of Shipping, Ramsden Square, Barrow-in-Furness.

Forster, William James, Ship Draughtsman, 10, Chester Street, Middlesbrough-on-Tees.

Knox, Robert, Ship Draughtsman, 14, West Avenue, Gosforth, Newcastle-upon-Tyne.

Lowes, J. Alfred, Engineer, Maritime Buildings, St. Thomas Street, Sunderland.

Page. F. J., Engineer Lieut. R.N., 4, Alexandra Crescent, Newcastle-uponTyne.

GRADUATES TO MEMBERS.

Andrew, David, jun., Engineer, 33, Osborne Road, Jesmond, Newcastle-upon-Tyne.

Barr, Robert Houston, Engineering Draughtsman, 40 Oxford Street, Barrow-in-Furness.

Sinclair, W. Rendall, Engineering Draughtsman, 1, Stratford Villas, Heaton Newcastle-upon-Tyne.

ASSOCIATE.

Allan, Alex. Selkirk, Manager, Messrs. Recorders, Limited, 171, Queen Victoria Street, London, E.C.

GRADUATES.

Bainbridge, Thos. Lindsay, Apprentice Shipbuilder, Holmwood, Newcastle-upon-Tyne.

Blake, Leonard James, Apprentice Engineer, 20, Laburnum Avenue, Wallsend-on-Tyne.

Cox, Harry Jasper, Apprentice Shipbuilder, 21, Victoria Square, Newcastle, upon-Tyne.

Hermon-Hodge, Harry Baldwin, Apprentice Shipbuilder, 19, Prudhoe Terrace Tynemouth.

Henderson, Joseph Nevison, Apprentice Engineer, 60, Woodbine Street, Gateshead-on-Tyne.

Stanger-Leathes, C. Francis, Apprentice Shipbuilder, 192, Heaton Road, Heaton Newcastle-upon-Tyne.

Tait, Robert, Apprentice Shipbuilder, 192, Heaton Road, Heaton, Newcastle-upon-Tyne.

Watson. Arthur William, Apprentice Shipbuilder, 29, Front Street, Tynemouth.

Webster, Peter, Ship Draughtsman, 22, Lesbury Road, Heaton, Newcastle-upon-Tyne.

DEATH OF MR. ANTON GEORG. SCHAEFFER.

The PRESIDENT said—Before commencing with the general business of the meeting, I have to announce, and I do so with the regret you all feel, the death of one of our oldest members, and a Vice-President of our Institution. Since our last meeting, Mr. A. G. Schaeffer has ended his life here. In Mr. Schaeffer's death, many of us have lost an old friend, the Institution a valued member, and the profession an able colleague, and I beg to move that the Secretary be, and is hereby instructed to convey to Mrs. Schaeffer and family, the condolence of the members of this Institution.

The motion was agreed to.

The SECRETARY read the report of the Educational Committee.

The discussion on Mr. Max Wurl's paper on "Technical Education in Germany" was resumed,

REPORT OF EDUCATIONAL COMMITTEE.

The Committee is, in the first place, of opinion that youths ıtending to qualify as artisans should receive while at school he best training possible, including, when practicable, some nstruction in elementary science, that more attention than at ›resent should be given in schools to the inculcation of habits f order, perseverance, and good conduct, and that apprentices hould be encouraged to continue their studies and the cultiva- ion of these habits during apprenticeship by a system of awards ffered by their employers. Hence the regulations proposed ıereafter for ordinary apprentices.

The Committee, in the second place, believes that industrial onditions in this country now call for some change in the ıethods of selecting and training those destined to work in the ıigher branches of engineering and shipbuilding. The Com- nittee feels that, if we are to maintain our position in those ndustries in which science now plays so important a part, more 'igorous efforts than hitherto must be made to secure the ıighest and most suitable education and training for adequate ıumbers of selected youths. As it is obvious that the attitude ›f employers will largely determine whether such youths will be nduced to equip themselves for competition on equal terms with he more highly trained young men of other nationalities, the Committee has ventured to put its recommendations as to pupils n the form of regulations suitable for use in works. It is ›arnestly hoped that, in the interests of all concerned—both ›mployers and employed—these regulations will be generally ıdopted.

The object of the increased pay attached, in the regulations 'or pupils, to educational qualifications is intended to serve as ın immediate inducement for youths to voluntarily undertake he severe discipline, self-denial, and hard mental work entailed ›y systematic study in the higher branches of their profession.

As regards probable numbers of pupils, it is estimated that the ›bject aimed at would be attained if each firm were to take, say, an ıverage of two fresh pupils each year (large works taking more, ınd small works fewer), making for a six years' pupilage, three

of which will be spent at College, a total number of six pupils in the works and office at any one time, the total extra cost in wages being estimated at something like £40 per annum, on an average, for each firm.

To obviate confusion and misapprehension, the proposed regulations are presented under two heads: first, those dealing with ordinary apprentices, and second, those dealing with pupils.

The term "apprentice" is to be understood to refer to those who enter the works to learn one or other of the trades or handicrafts therein practised, who serve the usual term of apprenticeship in the works, who may or may not attend evening science classes, but who do not attend a systematic University College day course of instruction during their apprenticeship, and whose object is to qualify as tradesmen, mechanics, or artizans.

The term "pupil" is, on the other hand, understood to refer exclusively to those who enter works, not with the sole view of becoming expert in any handicraft, but with the view of thoroughly fitting themselves for ultimately rising into the higher branches of the profession of engineering or shipbuilding, *e.g.*, draughtsmen, managers, superintendents, inspectors, consulting experts, employers, etc., who may or may not attend evening science classes, but who either have already attended, or will attend, a systematic course of instruction at University College day classes.

REGULATIONS.

I.—Regulations for Apprentices.

In starting apprentices, preference will be given to those who bring the best certificates of conduct and character, and the highest school leaving-certificates. The age of starting should be from 15 to 16 years.

At the end of September in each year, each apprentice will be awarded marks as follows:—

For each approved examination passed during the year	20	marks.
For time-keeping, a maximum of	40	„
For good conduct, perseverance and progress in the workshops, a maximum of	40	„

Marks for time-keeping will be deducted at the rate of one mark for every three hours lost, but no deduction will be made for special leave, or for sickness if certified by a doctor.

Conduct marks will be awarded quarterly by the chief foremen of departments on the following scale:—

Very good...40 marks. Good...30 marks. Fair...20 marks. Moderate ...10 marks.

An apprentice obtaining 60 marks will have the sum of sixpence added to his weekly rate of pay for the ensuing year, and for marks in excess of 60 his rate will be proportionately increased.

For example, an apprentice who in any one year passed in two science subjects at an evening science school will be entitled to 40 marks, for very good time-keeping 40 marks, and for general good conduct, perseverance and progress in the workshops, a maximum of 40 marks; total for the year 120 marks. This will entitle him to an increase of one shilling per week on his rate of pay, say, from October 1st for one year, but payments under this scheme will cease on the termination of apprenticeship or on dismissal.

Should an apprentice obtain, say, 30 marks for time-keeping, and 40 for good conduct, perseverance and progress, or a total of 70 marks, his rate of pay would be increased sevenpence per week, and so on.

No payment under this scheme will be made to apprentices obtaining less than 60 marks, and apprentices who fail to obtain any marks for time-keeping, good conduct, perseverance and progress will be subject to dismissal.

Apprentices commencing their apprenticeship between October 1st and March 31st will be entitled to half-rates for their first year.

Promotion in the workshops will depend upon marks obtained. Should an apprentice during the first three years of his time have shown marked ability at the evening classes, and obtained maximum marks for time-keeping, perseverance and progress in the workshops, he may, at the discretion of his employer, be allowed to spend his fourth or fifth year at College day classes, the fees for which will be paid by his employer.

At least one vacancy per annum in the drawing office will be filled by an apprentice obtaining the highest marks under the above scheme.

II.—Regulations for Pupils.

Scheme A.—Youths who have passed through a three or four years' engineering day course at an University College, and who have obtained therefrom either an approved certificate, or a pass degree in engineering science, or in naval architecture, may be admitted into the works as pupils.

They will serve a three years' pupilage, and for their first year the scale of pay will be that of an ordinary apprentice of the *third* year. The scale of pay for their last two years will be that of ordinary apprentices of the fourth and fifth years, plus 3s. and 5s. per week respectively.

Those who hold a degree with honours may be admitted on the same conditions as the above, but the scale of pay for the last two years will be increased by 4s. and 7s. per week, instead of 3s. and 5s.

Scheme B.—Youths who desire to combine workshop experience with College study, and who hold no certificate or degree from an University College, may be admitted to the works as pupils on the production of evidence that they have received a sufficient preparatory education. A certificate shewing they have passed the matriculation examination required for graduation in Engineering science at a Science College of University rank, or an equivalent certificate, will be accepted as evidence of this.

They must give an undertaking that they will attend for at least three academical years, the degree course of study at an University College during the currency of their pupilage, which will extend over a period of six years, including the time spent at College.

Their pay will be that of ordinary apprentices in the corresponding years, plus 4s. per week in years subsequent to their first year's College training. (See Appendix for suggested division of time.)

Scheme C.—Youths who, having entered the works as apprentices, succeed during their apprenticeship, in passing the matriculation or equivalent examination prescribed under Scheme B, will for the remainder of their time be treated as pupils under Scheme B, in respect of leave to attend College day classes, promotion, and rates of pay. The time served, including that spent at College, will be a minimum of six years.

It is understood that in every case the advancement of an apprentice to pupil rank is at the option of his employer, and subsequent promotion will depend solely upon merit, and the requirements of the business.

In selecting under Scheme C, other things being equal, preference will be given to the sons of workmen and other employees of the firm.

Promotion in general, and admission to the drawing office in particular, will depend absolutely upon merit and conduct in all cases. This clause refers to Schemes A, B and C.

Premium Pupils.

In the case of pupils who pay a premium, it is recommended that so far as College training is concerned, they should be asked and encouraged to conform to the regulations under either Schemes A or B, whichever is more suitable to the circumstances of the individual case.

(Signed) John Tweedy, Chairman.
John Duckitt, Secretary.

APPENDIX.

The time of pupils under Scheme B, may be divided in any of the following ways, according to circumstances:—

1st Alternative.

	Months.
Works	12
College	9
Works	15
College	9
Works	15
College	9
Works	3
Total	72

2nd Alternative.

	Months.
Works	12
College	9
Works	15
College	21*
Works	15
Total	72

3rd Alternative.

	Months.
College	9
Works	15
College	9
Works	15
College	9
Works	15
Total	72

4th Alternative.

	Months.
College	9
Works	15
College	21*
Works	27
Total	72

* Including 3 months' holiday in summer.

ADOPTION OF THE REPORT.

The PRESIDENT—I do not think it is necessary for me to say anything in support of a proposal that the report should be adopted and circulated. All here are perfectly familiar with the arguments in favour of establishing closer relations between the school, the college, and the workshop. This subject having already been so much discussed, and as we have a very long programme before us, I propose to content myself with simply moving "That the report of the Educational Committee be adopted, and that it be an instruction to the Secretary to circulate it."

Mr. J. R. FOTHERGILL, Vice-President, said—I feel it an honour being asked to second the President's motion for the adoption of this report. The report, after very careful consideration, has been drawn up by a Committee (specially nominated by the Council of the Institution) of gentlemen who have a thorough knowledge of the subject, and are conversant with the requirements necessitated by the development of the times. That fact in itself is of great weight, and should enable you without difficulty, to agree with the report. Of course, in a report of this description, you will readily understand, the Council felt it impossible to lay down anything of a definite nature. They could not presume to dictate to employers what they should do in their works. The report is essentially a basis on which each firm can erect their own edifice. It is more or less a suggestion from the Council, and it is hoped, with your consent, from the whole Institution to the employers, not only of this district, but throughout the country. This report was very fully considered at a Council meeting, and I may say, as I was present at that meeting, it was, after discussion, unanimously adopted, and it was suggested that copies should be circulated, as the President has moved in his resolution. I have also authority for saying that this report has been placed before most of the employers of the district, and has very largely their consent as to the basis on which it is drawn up. Of course, you can well realise that there are side issues in which various individuals may have some feeling one way or the other. An employer may say, "I do not care to adopt that report as a whole,

as it does not suit the general arrangement at present existing in my works, but as a basis for our present arrangement to face into line, I am willing to accept it." This is really the object of the report. The Committee fully considered what is being done by various firms, and endeavoured to draw up their report to conform with existing requirements, as a basis on which employers could associate existing schemes.

There is one question which perhaps I may touch upon, and that is what is known as Mr. Yarrow's scheme. Personally, I am in favour of this scheme, and I know many who strongly support it, viz., six months at college in the winter, and six months at the works in the summer; but, unfortunately, our college-arranged sessions, as a whole, throughout the country do not lend themselves to the Yarrow scheme, and thus the Committee in an appendix wisely suggests a choice of arrangement *re* attendance at college. It is not my intention to criticise the report, particularly as it was fully discussed in Council. I am sure you will all agree it is a very marked advancement on the past, it shows that employers take broader views and a wiser interest in their apprentices, to their mutual advantage, and to the ultimate benefit of the State; and I cannot conceive I am wrong in anticipating that the scheme will have your unanimous support. It is not a question of criticism of side issues and small details, but a broad basis on which we may all agree and in that sense I hope you will agree with its adoption, which I have great pleasure in seconding.

Mr. G. B. HUNTER said—I have much pleasure in supporting the adoption of this report, for two reasons. I think the presentation of the report is a very important event in the history of this Institution, and it is very likely that, when we look back in future years, we shall feel that, more even than we do now. I also think it desirable that there should be some expression of opinion in favour of the report, in addition to what has fallen from the President and the seconder of the resolution, and I desire to express a strong hope that this will by no means remain only a report, but that all the members of the Institution will not only consider it very carefully but will endeavour to use their influence in favour of the recommendations in the report being carried into practical effect in the workshops

of our district. I hope not only that the employers present will decide that they will endeavour to adopt the recommendations of the Committee as far as possible in their various works, but that those who have the direction of those works, the principal managers and the managers of departments, will use their influence with their respective firms, and that we shall find, that if not the whole, at any rate, the most of the recommendations of this report will be quickly adopted throughout the North of England, with which we are more particularly concerned. I was very glad Mr. Fothergill pointed out that the Committee has not the idea of presenting a complete scheme, which must be adopted in its entirety or not at all. They quite recognise that there is room for variations in detail, and for my part, I think it is very desirable that some modifications in details should be tried in the various works, because by that means we shall, in the course of time, better ascertain what is the best system as a whole, and shall find that the modifications most worthy to be adopted, will survive and be gradually adopted by other firms, and we shall obtain in that way, I hope, a very perfect scheme of assisted education in our works. Although a member of the Committee, I am afraid I have been an outside member—I am not entitled to share in any credit for this valuable report—but I take it that one of the advantages of introducing its recommendations to the various works, will be that they will greatly encourage the young people who are growing up, and who are to be our successors, to improve themselves, and engage in such studies as will help them in their work. They will also be greatly encouraged in good conduct and regular attendance. In saying that, I do not suppose for a moment that the slight increase of pay which is suggested by the Committee, will be the whole of the incentive to the apprentices to try and improve, and do well generally. The fact of being distinguished by receiving this mark of good conduct and this mark of progress in their studies, will itself be an incentive far beyond, I think, the slight increase of pay which they receive. Personally, while I appreciate and value the attention the Committee has paid to the encouragement of higher education for those to whom we look first, perhaps for our managers and chief draughtsmen—those who leave public and private schools to enter engine works and shipyards, I feel at present specially interested in the training and education of our

ntices and workmen. We shall find, I feel sure, proportion of our men and boys will begin seriously ate and improve themselves, and make themselves profession—and I may here say in our works at now have the satisfactory knowledge that about cent. of our apprentices attend evening classes; and I have every confidence that among these men and apprentices, are aided by the educational system recommended by your committee's report, here and there one and another will be found who possess special talent and ability. Some brilliant representatives of our profession in the North of England will be trained and developed, and we shall be very proud of them. At any rate, we will give these young people a chance, and for this, if for no other reason, I hope the report will not only be adopted, but that a serious attempt will be made to carry it into effect. I think we will have every reason to congratulate ourselves in the future on the results.

The motion was unanimously carried.

The PRESIDENT—I hope this holding up of hands will not be taken as an end of this matter, but that we will realise that our work has just commenced. It is hoped that every member of the Institution will feel it his duty to do everything in his power to bring about the improvements in our methods, which it is believed, will benefit employers and the employed alike.

RESUMED DISCUSSION ON MR. MAX WURL'S PAPER ON "TECHNICAL EDUCATION IN GERMANY."

The PRESIDENT said—A letter on this subject has been received from Mr. Yarrow. He is taking a very great interest in this matter, and he has been the pioneer, in the south certainly, in the adoption of improved methods in the works. I will ask the Secretary to read the letter.

The SECRETARY read the letter, as follows:—

DEAR MR. DUCKITT,

I have read with much interest the paper by Mr. Würl on "Technical Education in Germany." It is an exceedingly valuable contribution, especially at the present moment.

All business men will admit, as a standard axiom in political economy, when there is a demand it is followed by a supply. Now the inferiority of our educational system is, I believe, in a great measure due to the little interest parents take in the education of their children, and the want of appreciation and interest on the part of both parents and employers in the scientific training of those whose future path in life will be that of a profession based upon science.

I should like to more fully explain what I mean. Take, for example, the case of a young child who is sent to school for the first time. How is the school determined upon by the parents? I find it generally resolves itself in the selection of a kindergarten school that some ladies have started who find themselves unfortunately in a difficult financial position, but who know nothing about teaching, or it may be conducted by a gentleman who has failed in every other occupation. The school is probably selected by its being near to the house where the child lives and only "just round the corner," and convenient for a maid to take the boy or girl without interfering with her duties in the house. No one probably takes any trouble to know how the teaching is carried out. Later on, the child leaves the school for a more advanced one; and I cannot do better than relate what happened in

my own case. Two of my daughters went to a very good day school, and I expressed the wish that at the end of every term their note books should be sent home for my examination. The head of the school expressed a little surprise at this request, saying that formerly it was their practice to send all school books home at the end of every term with each scholar, to enable parents to judge for themselves what progress had been made; but it was very rarely found that the parcel of books had been opened, and it was generally returned to the school at the beginning of the next term in the exact state that it had been sent.

Again, when a boy goes to a big public school, how much interest do the parents take? It cannot be better illustrated than by the remarks recently made to me by the headmaster of one of our best schools. He said:—"The mother generally interviews the matron and gives her a few instructions with regard to the health of the boy, and she has a look round the dormitories to satisfy herself that the rooms are suitable. Parents' instructions are frequently limited to a request that the boy shall be brought up 'a gentleman' and that due attention shall be paid to football and cricket. The course of studies is very rarely touched upon, and the father's conscience is set at rest when he sends a cheque for the term's fees."

Now, I contend that parents fail in their solemn duty to their children by taking so little trouble to enquire what they are taught or how they are taught. I do not think that parents should shirk their duty by trying to put it on to the shoulders of others, whose chief interest is often only a pecuniary one. Of course I do not suggest for parents to interfere with the organisation of a public school; but I do think that they should take more trouble to enquire into the efficiency of the teaching and the subjects that are taught, with a view to judge for themselves if the best result is likely to be thus secured, having regard to the probable future of the lads. For example, many men of sound judgment are of opinion that spending the two first hours of the day in acquiring a smattering of the dead languages might be better devoted to the study of some subject that will have a more direct bearing upon the future career of their sons.

Now with regard to the technical colleges and the scientific branches of universities, I am convinced that the professors are anxious to do everything in their power to carry out what may

be considered best. The weak point is that the necessity for scientific training is not generally appreciated either by parents or employers, and in this respect we find a very marked contrast between Continental and American employers compared with the British.

In talking over the matter with the heads of many firms, one is often met with the remark, "Well, you see how I have got on and I am not a scientific man!" The answer to that is clearly, "If you were to start in life now with the little scientific knowledge you had formerly you would probably turn out a failure."

I submit that although a young man may have been through a scientific course at a technical college it does not follow that he will become a good engineer; but it must be admitted that if we were to take a dozen young men who had had a scientific training and a dozen who had not, the average success of the former would be very superior to that of the latter.

There is one very important point that requires immediate attention, namely, to endeavour to get the public schools to work in harmony with the technical colleges, so that when a young man leaves school he should be properly equipped to enter the technical college. At present it is found that most young men, on entering technical colleges, have to spend the first year of their time in studying what they ought to know, and could have learnt with proper teaching, before leaving school.

Standardizing is a very good thing for screw threads; but we must avoid standardizing education to too great an extent, which would cripple the elasticity that is necessary to conform to the various conditions and circumstances. What I say is that the public schools should make a point of training their boys with a view to fit them to take advantage to the fullest extent of the next step in their training, whatever that step may be. Only a few days since, the headmaster of one of our great public schools expressed the wish to carry out what I have here described, and I invited him to meet several of the professors of engineering in London, with a view to the studies of one section of his boys being arranged so as to secure a continuity of work throughout the two periods of their lives.

As I said in the beginning, if there were a demand for proper scientific training, the supply would naturally come of itself; and the demand can only arise by parents and employers taking

more interest in the matter and appreciating more the future effect on young people and on the nation of a carefully considered course of training.

Yours faithfully,
A. F. YARROW.

Mr. W. G. SPENCE said—Before saying anything on the subject of the paper, I think I cannot do better than thank Mr. Wurl for the very full and clear way he has brought it before us. His paper and the tables annexed thereto form a valuable record for reference. This paper on "Technical Education in Germany" comes before us at an opportune moment, coinciding as it does with the placing before the Institution of the Educational Committee's report. Referring to the latter first, I take it that the view of the Committee is that they are not alarmed in any way about the education of our workmen, but with regard to the staff of the works, namely, foremen, draughtsmen, chief draughtsmen and managers, they consider that greater attention should be paid to having these thoroughly grounded and trained in the underlying principles of their profession, which can only be attained by study outside the works. With a view to comparing our system of training with that obtaining in Germany, I have attempted to, as it were, focus Mr. Wurl's paper by the aid of a diagrammatic synopsis as shown in Fig. 1 (Plate I.) and comparing this with a similar diagram Fig. 2 (Plate I.) showing the system (if we have any in this district) obtainable by works apprenticeship, together with study at, say, the Durham College of Science. The principle on which the diagrams are constructed is by showing in different colours on a scale, the ordinates of which are divided into years, the varying quantities of mental food attempted to be assimulated by the embryo engineer in given periods. In both the German and English diagrams I have used the same colours to indicate similar stages, or types of education. Taking the German system first, and assuming our future engineer comes of parents who can afford it, and elects to go in for the highest form of technical education attainable, namely, that in the left hand columns, we find that he first attends the "Vorschule," which seems to be a German equivalent to our preparatory schools, until he is about 9 years of age, as shown by the neutral colour. On reaching this age he enters

one of the three classes of secondary schools (shown in red), and which appear to be equivalent to our Public Schools, High Schools, Grammar Schools, etc. The main distinction between these schools and ours would appear to be:—

(1) In Germany these are sub-divided into three distinct schools one confining itself to giving a classical education (Gymnasium), another giving a purely modern education (Oberrealschule), while the third takes up an intermediate position (Realgymnasium).

In our similar schools there is no such clear distinction, many endeavouring to meet the want by cutting themselves in half, and having what is termed a "modern side" and a "classical side."

(2) All secondary schools of a given type in Germany have the same curriculum; thus, if you know a boy is in, say, the fourth class you know at once how far his education has progressed, no matter what part of Germany his school may be in. In our system, except in the Board Schools, the subjects taught in the various classes or forms are as various as the names of the schools, and it is impossible to tell how far any boy's education may have progressed without questioning him as to what he is doing.

(3) In all schools in Germany the whole class is moved up to the next above at a given time and boys failing to qualify for promotion must remain in the lower class for another year. This must act as a healthy stimulus to the lazy.

(4) In Germany they have an excellent system of encouraging all boys to attain a certain standard of secondary education by their examination for one year's military service (black cross in diagram). When a boy reaches a certain class he sits for this examination, and if he passes he is required to serve one year only in the army, whereas if he declines to be educated up to that class, or fails to pass, he must serve for at least two years. The importance of this stimulus cannot, to my mind, be over-estimated, as it appeals to the parent as much as to the boy, and we may be certain the former does not

forget to rub it in. The mere difference of one year in the army, as against two, might not appeal so much in itself to the boy, at any rate until he got there, but there are other additional advantages which certainly will appeal to him. For instance, the one year's man joins a distinct caste in the army. He wears a distinctive mark on his uniform, and is not required to live in barracks like his two years' brother, but may live at home, and is relieved of many of the fatigue duties, such as sweeping up barracks, etc., and on leaving the service is eligible to be appointed on the staff of reserve officers, while the two years' man must serve in the reserves as his subordinate. In short, the one year's man is the full-blown fighting, military man, and the two years' one is the drudge. The effect of this spur to secondary education, extending as it does to all classes and every walk in life, must act as a very healthy leaven throughout the population, as no able-bodied boy can escape, no matter whether he be duke's son or cook's son, or whether he must work to live or can afford to live in idleness. In our similar schools we have no corresponding spur to duty, and many boys do not see the necessity for study until they reach years of discretion, whenever that may be, and find themselves regretting much valuable time lost. If the masters and boys in our similar schools had to face a similar test one can only believe the result would be for the general good.

Having passed this test, the boy remains in the secondary school, and is at once confronted with a second test, viz., that if before leaving school he does not succeed in gaining his "maturity certificate" (black cross in diagram) he can never take any degree in the Technical High School which is his ultimate goal. To clear this barrier he will require other three years' study, after which he is allowed some breathing time by putting in one year in the works (marked in black in diagram) and one year in the army (green in diagram) after which he enters the Technical High School (brown in diagram), at a minimum age of 20. Here, as Mr. Wurl says, he is allowed the utmost liberty, and can study or idle as he pleases, but he is never allowed to

forget that after he has been in this school two years he will have to sit for his "preliminary examination" (black cross in diagram), and if he fails in this, can never sit for the final examination for Dip. Ingr. (black cross in diagram), which takes place at the close of his four years' course, his minimum leaving age being then 24 years.

Broadly speaking, then, the outstanding feature of this course of education, from beginning to end, seems to be that the aspiring engineer is urged ahead by a system of well-arranged spurring, the spur being applied at judicious intervals, and the earlier one arranged to act as a spur to the parent and to appeal to the feelings of the boy in much the same way as a carrot does when hung before the nose of a certain animal. The black crosses in the diagram show the respective digs of the spur.

If, instead of the above curriculum, the boy decides on attaining a lower standard of education, and spending a longer period in the works, he can select any of the other arrangements shown towards the right of the diagram, the amount of technical education diminishing as we move towards the right, until the lowest stage of all (on the extreme right) is reached, where no attempt is made to either attain the one year exam. standard before beginning work, or to study after work has commenced; such a course as might be adopted by a boy who had no ambition beyond becoming a working mechanic. To assist boys who elect either of these paths, we notice there are two classes of technical schools below the High School, namely, the Technical Middle School (brown in diagram) and the Technical Lower School (yellow in diagram). The whole forms a graduated scale, from which can be selected, as may be wished, a course with as much, or as little, educational assistance as may be considered desirable.

Turning now to the English diagram (Fig. 2, Plate I.), I have arranged courses of training in a similar manner to the German one, the higher education courses being on the left, with a reducing quantity of the educational constituent as we move towards the right.

Sir W. H. White—Have you not put the school leaving age (15) of the boys in the columns on the right rather higher than is usual with this class of apprentice?

Mr. W. G. SPENCE—Probably it may be rather higher than the average. We get them at all ages from 13 to 16, and I have struck the line at 15, although undoubtedly a large number begin earlier in life.

Summarizing the two diagrams roughly, the salient points appear to be:—

(1) The greater preponderance of the educational colours in the German diagram.

(2) The more highly educated man in Germany begins to earn a living considerably later in life than his compeer in England, whereas the reverse appears to be the case with the ordinary mechanic. In Germany the latter appears to become a journeyman earlier. Our youths seldom complete their shop apprenticeship under the age of 21.

(3) In Germany, the whole nation is spurred to attempt to gain a good standard of secondary education by the system of exam. for one year's military service. While those who elect the highest form of technical education are further spurred on, and guided in their course, by additional successive examinations.

The problem as to how much, or how little, technical school education may be advisable as the best training for a given position in a given branch of engineering is a difficult one to answer. It does not necessarily follow that because a youth has undergone the highest attainable curriculum, he is therefore an able engineer. I think it was Sir Joshua Reynolds who remarked that "God Almighty alone made painters," and the same might be said of engineers; but it does seem reasonable that an average set of youths of "mechanical turn," as their parents so often put it, would on the whole be better engineers generally if thoroughly grounded in the principles of their profession than if left to pick up these principles in the few hours of leisure at the disposal of those who serve their apprenticeships wholly in the works. At the same time it must not be forgotten that before any technical school education can be successful a substantial basis of secondary education must first have been laid.

Mr. H. M. MACMILLAN said—I have great pleasure in taking part in this interesting discussion on the important matter of

technical education, and in adding my testimony to the admiration that has been generally expressed for Mr. Wurl's paper, but I am not aware that there is much left for me to say which has not been already considered by other members.

In reading through Mr. Wurl's paper, the first thing that strikes me is the continuity of the system of education in Germany and its perfect uniformity; and in these respects I think our code compares very unfavourably with the Prussian. A child here, whose parents leave one part of the country for another, too often finds that he cannot continue his education exactly where he left off, and the same thing may be said in varying degree as his education is continued from an elementary school to a secondary, from that to a technical college, or from there to one of the universities. There is a leak at each stage. Indeed, notoriously, a degree from one university indicates a very different educational standard to the same degree from another university or college. These are decided defects in our system, and I think they are points in which our institutions should be altered. Nothing of the kind, we learn from Mr. Wurl, is possible in Germany.

The next thing that strikes me is the matter which Prof. Weighton and other members have already noticed, and that is the excellent and specialised teaching that the most advanced German students can obtain. In this country nearly all the authorities of the universities are calling out about their painful deficiency in the teaching staff. In those universities where engineering is taught at all, one professor is expected to take over the whole of the science in all its many and increasing branches, and is presumably supposed to be able to impart the most advanced instruction which it is possible to acquire, with the help of two or three assistants and lecturers; and in naval architecture there are only two professorships, I think, in the kingdom—in the greatest shipbuilding country of the world. This, together with one lectureship in the Durham College of Science, absolutely exhausts all the tuition in the subject which students at day colleges can obtain. It is to our greatest discredit that this should be allowed to be so; I think I am not wrong in saying that we were about the first country to have regularly established technical schools and colleges, and yet we have allowed Germany to get right ahead of us, as well as,

in many respects, France and the United States. Japan also is moving forward very fast in these matters.

It must be very gratifying to all the members present to-night to learn what has just been done in the way of encouraging engineering and other technical education amongst apprentices, and to hear from the President that a Committee has been formed to push the matter forward; but it is also important that we should take care to see that our colleges are adequately endowed and have a sufficient number of professors and qualified lecturers to give instruction to the pupils and apprentices whom we desire to induce to attend college. I do not think it is a bit of use expecting clever lads to cut themselves apart from their practical work, and to attend college, unless they are pretty sure that they are going to get much better and more specialised instruction than they can otherwise obtain. I know many men who could have continued their studies at college after the completion of their apprenticeship (for, unfortunately, facilities did not then exist for college attendance *during* apprenticeship) but did not, from this conviction, and several others who did so, and did not consider the investment a very profitable one, educationally. That is a very regrettable state of affairs and should be altered. In this connection, however, it is worth while noticing the unfortunate attitude, in my opinion, taken by many academical people in universities, regarding technical education. It is very tersely put by one of these gentlemen, in one of whose addresses I recently noticed this passage, "Wherever you find a great university, you find the arts and the pure sciences in a flourishing condition, with the technical and applied sciences grouped around them in *decent subordination*." This is doubtless a mere statement of fact, but I have never been quite able to understand why it should be so, inevitably. Why a man who laboriously trys to obtain some working acquaintance with a few of the applications of the laws of nature should be held to be on a lower intellectual plane to the person whose mental culture is developed by, or is identified with, the study of the junkettings of a lot of mythological and somewhat preposterous ancient deities, is a thing I do not comprehend, and I think this is another subject which we should consider soon. We have learnt from Mr. Wurl that such a difference does not now exist in Germany, and that all credit is due to the Emperor for his part in the reformation.

The attitude of many of the manufacturing classes in this country towards technical education was in a sense at the other equally objectionable extreme, and is now happily rapidly passing away. We have all met the man who said that scientific education was useless in practical life, and who knew someone who came from a college into the drawing office or shops, but could show them nothing and knew nothing of the business. Well, I think it would not be saying much for the intelligence of the people engaged in engineering and shipbuilding if it were possible for anybody to come straight from an university, with no practical knowledge of these professions, and put us right in our affairs; it is as necessary for a man to have a working knowledge of mathematics and dynamical principles as it is for him to know technical terms and actual methods of working materials if he is to take any progressive part in his business, but I think the necessity for a sound practical experience should not be lost sight of, and this raises another point in Mr. Wurl's paper.

We see at a glance from Mr. Spence's chart, that the most highly trained class of student in Germany does not complete his course till the age of 24 or 25, and in all that time he has only had one year's workshop practice. For other branches of engineering, which possibly pertain to being more in the nature of exact sciences, I do not profess to be able to speak, but I do not think it is possible for any man whose life is to be spent in shipbuilding to obtain a sufficient knowledge of it by one year's practical shipyard experience; a greater part of his life, when he is 25 years old, should have been spent in a yard than that. However, in this respect we have an advantage here over Mr. Wurl's countrymen; we have no compulsory military service, and therefore two years practical work could be put in by a British student going through the same curriculum, but I think three would be a safer minimum, and after all, some definite time must be fixed on. It certainly seems quite a waste of time for a well-educated youth to have to spend five, six and sometimes seven years of apprenticeship at practical work, as is the custom at present with us.

The technical evening classes throughout this country have done incalculable good, and, it is to be hoped, will continue to do so; but I am afraid, as far as my experience has gone, the

percentage of students who derive permanent benefit from them is not so great as is sometimes supposed, and I do not think it is reasonable to expect that people engaged in works all day can learn and retain very much by attendance once or twice a week at classes in the evening. Undoubtedly some of our best men have had no other means of continuing their education, but this only proves that they were possessed with innate energy and ability, in spite of the defective system of education they have had to be content with; and in any case, the effort required to get lasting benefit in this way is much more than there should be any need for on the student's part. I am convinced that it would be better to direct our efforts in the way of offering inducements to the best apprentices to take a systematic course of study at a technical college or university, so as to obtain the highest education it is possible to obtain, rather than to be principally interested in seeing that all apprentices attend simpler classes in the evening. It is better to develop a few really excellent men than to expend the same or more capital in producing a great many, only slightly better than they would otherwise be. It is perfectly astonishing—and I speak from considerable experience and observation—to find in drawing offices the number of apprentices who, having industriously attended evening classes, for several sessions, yet show the most confused notions of elementary mathematics and have no confidence whatever in their own applications of the simplest functions.

Mr. Wurl takes notice, in connection with the Hochschulen, of the almost unlimited amount of "academical liberty" which the student enjoys; and he is apparently a strong advocate of the system. I am afraid I am not at one with him there. Possibly in Germany, where attendance at these institutions represents a more rigorous application of the law of the survival of the fittest than with us, such an untrammelled course may be safer, yet I cannot but think that it must, on the whole, make for slackness and inefficiency. I must confess that I should often have liked to have had more academical liberty as a student, but I think now that the frequent examinations which we had to undergo were good for us. Doubtless some of the best students will work equally well without such an incentive, but I think most young men are the better for having such a weapon to keep them up to

the scratch and to foster what is generally a healthy spirit of emulation amongst them. The German curriculum is in this respect too Utopian, I consider. In Scotland the university student enjoys much more liberty in most ways than in England; but there are signs that the authorities there seem to be considering the desirability of approaching, as far as possible, the residential system of the English universities, which, if ever accomplished, will doubtless bring in its wake attendant regulations and restrictions of all kinds to the student's freedom. Perhaps the late Mr. Cecil Rhodes' will may have something to do with the movement, but it is interesting to note the tendency, at any rate.

I think Mr. Wurl is to be heartily congratulated for his valuable paper on this important subject.

Mr. J. R. FOTHERGILL, Vice-President, said—Mr. Max Wurl's paper is one of great importance and peculiarly interesting at the present time, when so much is being said and done in reference to education. I desire to thank the writer of the paper for the valuable information he has placed before the meeting and I feel sure the meeting will support me in thanking Mr. Spence for his very lucid speech and most graphic illustration which so forcibly places before the meeting a ready comparison of the educational systems now in operation in Germany and in England. There is no doubt, due to early surroundings and associations, very different views are held, particularly in reference to technical and scientific education. I quite agree with the writer when he says at the commencement of his paper, "one of these general views silently accepted by nearly all parties in Germany is that the kind of technical education which can be conferred on a man depends mainly upon his general education," etc. This opens up the question of education in youth. Unfortunately, I am afraid it must be admitted that a large proportion of the many private establishments throughout the country are most unsuitable schools for elementary training to ultimately attend technical and scientific colleges. Although it is a delicate question to refer to the teaching at private schools, yet many of these establishments, under some recognised educational authority, with proper supervision and examination, would undoubtedly produce far superior results.

The tendency at the present day in these schools appears to be to pick out the best lads and coach them for local Cambridge examinations and then advertise their success. My own experience at the Technical College, West Hartlepool, is that many youths who have been to what are termed excellent private schools are only capable of entering the most elementary classes, which is most unsatisfactory to the lad and his parents. Of course there are exceptions, but unfortunately they are the exception.

To attempt to discuss this paper in detail would occupy too much time, thus it is only possible to touch upon one or two points. As to the question of a lad attending college, particularly in reference to those who intend being engineers and shipbuilders, I am very strongly in favour of commencing their apprenticeship in the works after leaving school before taking up a college course, as at a susceptible age, he associates with men in every-day life and better realises the possibilities of his future life, besides obtaining a knowledge of the use and application of tools. After serving such apprenticeship until he is, say, eighteen, he should then be enabled to attend college during the six winter months, and return to the works for the six summer months, and so continue until he completes his apprenticeship. There are many valuable reasons for this course, so ably advocated by Mr. Yarrow. I cannot agree with the last speaker that technical evening classes have not a value. My own experience is they are of great value and well prepare a lad for college. They are valuable feeders to the college and give an excellent technical education of great value, particularly to lads whose parents cannot afford to send them to college. There is another question for deep consideration, and which one frequently hears mentioned, and that is what is to become of all the young men who are successfully passing through the many technical colleges now established? It is admitted there is a great dearth of berths for such highly educated attainments, and it is equally certain such lads will not with satisfaction return to the "hammer and chisel." No doubt another generation will alter matters, as many of the older type of employers fail to appreciate the advantages and possibilities of higher education. There is also a strong prejudice in works' foremen, and, I regret to say, even some chief draughtsmen are not in love with college lads. Time will undoubtedly break this down. We are passing through

a revolution, and until the advantages of education be thoroughly realised many successful students will find it difficult to obtain suitable berths. Professor Weighton and the last speaker rightly drew attention to the understaffing in our colleges, and certainly if we attempt to compare the number of professors and lecturers in our colleges with those given in the paper, it is so astounding that it is difficult to realise such is the case, and is direct evidence the State should render assistance, not only in direct financial assistance, but in picking out the brilliant lads having undoubted powers of application and natural aptitude, and give them a State education at recognised colleges. Probably the best plan might be to endow such colleges with a number of scholarships. Such State action would undoubtedly redound to the ultimate benefit of the country. There are other features associated with this paper one might desire to speak upon, particularly secondary education, a most important consideration, but having already exceeded the time at my disposal, and knowing there are others who desire to speak, I must retire, trusting others will take up this subject.

Sir WILLIAM H. WHITE said—I came here to-night with the desire to listen chiefly to the views expressed in this valuable discussion. I know that great attention is being given to this question on the North-east Coast; and this is of interest to me, as the Institution of Civil Engineers, of which I am President, is now taking action, which we hope may be useful to the engineering profession in the constitution of a general committee, which shall be representative of all branches of British engineering, and which shall endeavour to prescribe what is believed to be the best course of training for British engineering students under present conditions. It will be noticed from Mr. Wurl's paper that similar action by engineering societies was really the beginning of the existing system of technical education in Germany—a fact I was ignorant of until I found it in the paper. All the latest and best developments in Germany grew out of a special committee—what was the date, Mr. Wurl?

Mr. WURL—In the year 1888.

Sir WILLIAM WHITE—We here in England, without any knowledge of what had taken place in Germany, have reached

the conclusion, after very long debates, that the time has come for conference between those who represent the various branches of engineering in all localities; and the special committee is to be mainly constituted of practising engineers and employers. With all respect to Professor Weighton and his colleagues engaged in teaching, I think we who are doing the work are more competent than teachers to say what should be taught—not how it should be taught. I am not pretending to throw scorn on teachers, who obviously have the right to be heard. But those who should best know what is needed for the practice of engineering are those who are conducting the work. The opinions of teachers will, of course, be welcomed and carefully considered by the committee, but, as I have said, it will consist mainly of practising engineers, representatives of all branches, named not merely by the great central societies in London, but by the chief outlying associations in Great Britain. From such a committee it should be possible to get an authoritative statement, which must carry weight with the universities and technical institutions in the immediate future. By attending this meeting, I wish to do honour to your President, whose action in this matter we all esteem very highly. I came here also to hear at first hand what is the feeling of my friends and old colleagues on the North-east Coast as to the best method of proceeding. The discussion has branched off very much into a discussion of English technical education but the subject proper, of course, is technical education in Germany. I have read this paper very carefully. I have read a good deal about German technical education elsewhere. I have been in Germany and know all about Charlottenburg—what is called Charlottenburg—I mean the technical university and not the town; but I am bound to say the diagram prepared and described by Mr. Spence presents the facts as to German systems to my mind in a clearer and more abiding form than anything I have yet seen. We are greatly indebted to him for adding this graphic representation to Mr. Wurl's paper. I want Mr. Spence to give me a copy of that diagram as soon as possible for the use of the committee in London. The only criticism I would make on the diagram is that in the English system Mr. Spence probably advances too far the school-leaving age for ordinary poor boys in this country. I have no doubt most of them leave school at fourteen rather than at fifteen years of

age and many of them find casual employment as messengers and in such like ways before they become apprentices. The deplorable thing is, that the school training of the middle and upper classes is chiefly obtained in schools which are absolutely free from external and independent inspection or examination, where there is no authentic and independent test of either the capacity of teachers, the character of the courses of study, and the progress of pupils. When the term reports come in you are generally told that your boy has admirable ability, but is wanting in application. This is not satisfactory to parents and guardians, and the system needs changing. What we want to do is to learn from Germany as much as we can. Germany has learned very much from us. I have never been in Germany without hearing from friends the kindest references to the advantages of working and studying in England and it is our business not to be so stupid as to refrain from learning from people who have certainly a great talent for organization and administration. The Germans have based their scheme upon the pre-existing French system of education, which is simply admirable in its clear organization, and gradual advances from step to step. The Germans have taken that, and, as I think, have improved upon it. They have introduced at an early stage practical workshop and factory experience; but one year's workshop is not enough, although it is difficult to fix a limit. Some men have different eyes from others, which seem to take in more at a time. But the substantial fact which appeals to me, because it confirms what has been my own impression, is that the Germans insist that there shall be workshop practice before there is a commencement of higher technical instruction. When a man comes out of a technical high school fully qualified, he still has the honour of going on for a year or two, if he is going into the German public service, and proving his ability by producing a design. He is not merely twenty-four when he completes his technical high school training, but he has the honour and glory of paying for an expensive uniform, and working for nothing until he has justified himself by work. The Germans are not so liberal as we are. They expect men to justify themselves thoroughly, and provide themselves with a living rather later than we do in this country. I do not want to occupy the time of this meeting more, but I want

to say this—I have said it on several occasions before—that it is a disgrace to the North-east Coast that there should not be a Chair of Naval Architecture in the Durham College of Science. It is a disgrace that this great shipbuilding centre should not have a distinct and well-equipped Chair of Naval Architecture. I know these are not the times to call for heroic efforts in the way of generous giving, but I trust that this revival of interest in technical education will see that reproach soon wiped away. I have nothing but admiration to express for the way in which the engineering side of the College has been developed. No one has greater admiration for what Professor Weighton has done, and I hope it will be understood, in saying what I have said that I am not criticising the engineering branch. But that here on the North-east Coast there should be no separate chair for scientific instruction in naval architecture—that it should be a sort of annex to engineering—is really deplorable. It may not be an agreeable thing to hear, but I feel bound to say it. I hope to see at Liverpool also a Chair of Naval Architecture in connection with the University there. I feel sure it could be done; I am confident it could be done; but when people are working hard, as people here are, these things miss being seen. But, when the want becomes apparent, it is keeping with the north-eastern character to see it is supplied. Mr. Macmillan has made reference to evening classes. I agree with him that technical training cannot be completed in evening classes. I remember when Mr. Hunter started these evening classes at Wallsend, and I attended the first presentation of prizes. When I think of what that place has grown to be, and what has happened there—that there have been hundreds of young men going through the evening classes who have been helped to fight evil habits, whose minds and bodies have been wholesomely occupied, who have been saved from becoming Hooligans and made better men by these evening schools—I do say, although the classes are by no means substitutes for higher and complete technical training, they are one of the glories of this country, and I hope the time will never come when those who can only find time to attend evening classes will not have evening classes to go to. I will tell you what I saw myself about a fortnight ago, in London. It is an example of what can be done at little cost. I went one morning about two or three

weeks ago, to the Battersea Polytechnic, which is a large municipal technical school. There I found a class of from forty to fifty apprentices in the works of the South-Western Railway attending a morning lesson, when the boys were fresh, and their minds and bodies not tired. They are allowed to go there for two hours and a half on two mornings in the week, and the Company pays their wages while they are there. Their note books are carefully examined to give proof, that the morning instruction which the Company pays for, is supplemented by home work in the evenings. It costs the Company very little indeed. It is entirely the work of Mr. Drummond, the Superintendent of the Company, and he believes, and the directors believe, and I think you will all believe, that that modest expenditure of the Company, in giving to those boys such a means of instruction, will come back to the Company a hundred-fold. Mr. Drummond is looking forward to getting a gradual selection from these boys of those who can go further. He knows that his shop foremen will come out of this class, but of them will come also some boys of brains and ability, who will go higher. Then the Company will be able to say, "Go on higher, and we will help you to do it." A simple, straightforward effort like that, which means very little expenditure, is one worthy of the consideration of the great employers of this north-eastern district.

Mr. F. H. ALEXANDER said—I think that as the hour is so late, and as there are others besides myself who would like to make remarks on this paper, I move that we adjourn this discussion to a future meeting.

Mr. SHAW—I second the motion.

The PRESIDENT—It must be very gratifying to Mr. Wurl that his work has resulted in so interesting a discussion. I think the discussion can with advantage be continued, and I have great pleasure in supporting the suggestion that it be adjourned.

The motion was carried.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

THIRD GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY, JANUARY 22ND, 1904.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting held in Newcastle-upon-Tyne on Friday, December 18th, 1903, which were approved by the members present and signed by the President.

The PRESIDENT appointed Mr. David Andrew and Mr. G. D. Weir to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Murdock, Thomas Plunkett, Superintendent Engineer, 23, Lovaine Crescent, Newcastle-upon-Tyne.

Renton, James, Engineer, Engineer's Department, Trinity House, Tower Hill, London, E.C.

ASSOCIATE.

Evans, T. L., Ship Surveyor, 59, Broad Street, Bristol.

THE TRAINING OF ENGINEERS.

The PRESIDENT said—As some of you know, the Institution of Civil Engineers has established a Committee, composed of members from all Institutions such as this in the country, for the purpose of considering the training of engineers in all branches. This Institution, with others, has been invited to nominate a member, and I have to report that the Council has nominated Professor R. L. Weighton to represent it on that Committee.

NEW VICE-PRESIDENT.

The PRESIDENT said—I have also to report that Mr. R. Home Muir, a very old member, and one who has taken a very active interest for many years in the Institution, has been elected a Vice-President in the late Mr. A. G. Schaeffer's place.

The discussion on Mr. Max Wurl's paper on "Technical Education in Germany" was resumed.

Mr. J. H. HECK read a paper on "Notes on the Construction of Stability Cross Curves from Balanced Paper Sections."

RESUMED DISCUSSION ON MR. MAX WURL'S PAPER ON "TECHNICAL EDUCATION IN GERMANY."

Mr. F. H. ALEXANDER said—I think it is hardly necessary for me to add anything to what the speakers before me have said with regard to the value of Mr. Wurl's paper. The technical journals have made many references to it during the last few weeks, and that is a testimony to its worth.

The chief features of the German system, as outlined in the paper, seem to me to be (1) its excellent system of gradation, (2) its inducements to students to ascend to the highest grade, and (3) its elimination of the unfit at each stage. It is noticeable how large the staffs of professors and lecturers are, so that although the students are so numerous, the number per teacher is small.

Now with regard to all but the very highest grade, I think the system arranged by our British Board of Education covers a large part of the ground; but in this country, reliance seems to be placed too largely on the evening classes, and as has been hinted by one or two other speakers, the limits of the evening class system are rather a bar to the attainment of the highest grade. Fatigue of body and brain after the day's work unfit the student for getting the full benefit of either lecture or private study; and the fatigue is naturally most noticeable in those who have to go to handicraft work in the early morning. An important limit to their studies is brought about by want of time, in the form of an inability to take up more than one, or at most two, subjects during a session. Throughout my experience in shipyard drawing offices, I have been struck by the fact that ship-draughtsmen seldom attempt to carry on their studies in any subject other than naval architecture; and the higher branches of this often suffer for lack of a knowledge of mathematics, both pure and applied. Engineer students seem to be much more willing to widen the range of their studies.

I think a scheme such as that put forward by our Institution's Education Committee should have excellent results; and that from the ranks of the apprentices, who attend evening

classes to a sufficient extent to qualify them to pass a matriculation examination, we shall get some of our best men, for they will have had a good practical experience as well as their training in theory.

The suggestion has been made during the discussion that the German "academical engineer" may be too academical, as he goes through only one year's practical training or workshop practice. It depends on what you want him to do. In reference to that year Mr. Wurl says, "It is not intended to teach him a handicraft, as such, but to give him an idea about the conditions, means, and limits of manufacture and workmanship." I should like to know just what he does to give him that knowledge. Has he definite work to do during the official hours, or is he given a free run of a firm's premises? I can understand a man of intelligence picking up a very great deal in a year if allowed such a privilege. With regard to the limits of manufacture, to what extent is he allowed access to knowledge of financial limits, or the commercial side of the question? After he has had that year's practice, passed on to the technical high school, and completed his academical course, does he return to the firm which gave him the privilege, or is he free to go to another firm?

The number of students in naval architecture at Berlin, is, according to Mr. Wurl's statement, 382, and I learn, from another source, that for that subject alone there are 21 instructors, of whom 6 are professors. Now we have three colleges in this country which teach the higher branches of the subject, viz., the Royal Naval College, Greenwich (to which there is, I believe, an automatic supply of students from the Royal Dockyards), Glasgow University and Durham University, as represented by our College of Science, in Newcastle-upon-Tyne; yet I doubt if the total number of students of the subject in these three institutions is equal to one-third, possibly not to one-quarter of the number at Berlin. This small number of students in naval architecture is remarkable in a shipbuilding country like this. It is traceable largely, I think, to reliance upon the evening classes, to the want of demand for the higher work that the highly trained men are capable of, and as a consequence to the absence of inducement to men to qualify themselves. Mr. Wurl's final paragraph gives reasons

for the German demand, but I would like to ask whether the research work, referred to in that paragraph, is carried out by private firms, on their own premises, by retained specialists, or at the Colleges, by students under the supervision of the professors.

I think the age of the student should be taken into account, and unless ours are going to carry on their studies till they are 24 years old, I do not think we can expect them to have as profound a knowledge as their German *confrères*. The absence of a year devoted to military service gives us an advantage, and this period might be used for practical work as has been suggested. I would further suggest that a part of it should be utilised in visits to important ports to study the means of loading and discharging, etc., and another part spent at sea, with definite subjects for observation in connection with the behaviour and working of ships in service.

One is tempted to ask: What will become of those 382 students now at Berlin? Some, no doubt, may be failures, and some may not live to do work which they are qualified to do and shine in. Some will become managers, designers and draughtsmen and will do valuable work in suggesting new ideas and methods. There will be experts in deriving information from analysis of data, and from experiments. Some will join the registration Societies, others become teachers and professors, and others again may come to sojourn on this coast for a while and present us with papers as valuable as the one we are discussing.

In the remarks that were made at our last meeting, references were made to the teaching of naval architecture at the Durham College of Science, and as these references may give rise to misapprehension, I will, with your permission, make some comments on them. It would be very unfortunate if it got to be the idea in this district, that the College made no provision for the teaching of naval architecture in the highest grade; full provision is made there. The lecturer gives the whole of his time to tuition and demonstration and to superintending drawing-office work in the subject. The whole course of study has recently been thoroughly revised and reorganised, and provision is now made whereby a student not only reaches the standard needed to obtain the degree of Bachelor of Science in

naval architecture but a course of study is suggested, and works of reference stated, so that he may carry on his studies to the higher degree of Master of Science, after leaving College. I make bold to say that a student who can obtain the latter degree, is in this subject at least, on a level with the German students just completing their highest course, except perhaps in the matter of experimental work, for which I do not think our Colleges in this country have adequate provision as yet.

It should not be forgotten that the chair of engineering at our College of Science, includes naval architecture, and that the professor has the assistance of a lecturer who gives the whole of his time to this subject alone. The lecturer, or instructor, at Greenwich has not the title of professor, but I do not think that any one will suggest that the work is less efficiently carried out on that account. At the same time the establishment of a chair of naval architecture here would undoubtedly call attention to the fact of the subject being given a high and thorough place in the college course.

This is not the place to enter into the claims of research work in naval architecture, or a long list of problems requiring solution might be given. Our knowledge of ship stability, strength, resistance and propulsion is by no means complete. There are many points with which the shipbuilder has to deal in a hurry, and for which no useful and reliable approximate formulæ are to be found at present, such as could be derived from careful analysis and investigation. The power to carry out such investigation in a satisfactory way, can best be attained by means of a higher education such as we have been discussing.

Mr. T. Shaw said—I should like to add my quota of thanks to Mr. Wurl for his valuable paper on the interesting and important subject of technical education.

Although the German system was so lucidly and concisely set before us, it was somewhat difficult to remember the different stages and ages of the students and compare the same with our English schools until Mr. Spence produced his very clear diagram, giving in juxtaposition the facilities offered in the various countries named, it should, however, be borne in mind that the number of the different sections does not represent the capacity of various schools.

For comparison I give an epitome of English educational history: 1st, Primary—previous to 1839 no State education; from 1839 to 1869, grants paid to local bodies and no compulsion to establish schools where the provision was insufficient; from 1870 to 1890, publicly constituted boards; 1891, free education. 2nd, Technical—Evening classes conducted under the management of any local committee and grants, based upon the success of the students, paid by the Science and Art Department; and where apparatus was needed for the teaching of a subject it generally resulted in a monetary loss to the committee.

From the foregoing it is evident that technical education has received very little thought, help or monetary consideration from the State and the training obtained by our students has been principally due to private enterprise of which we have a fine example in the Durham College of Science.

The chief objection to the German system in my opinion is, that to enter the higher technical schools it is necessary for the student to have spent 6 years at a secondary school, one year in a workshop with no salary attached and cannot obtain his Dipl. of Eng. until 24 years of age, also the cost is from £840 to £1,160. The length of time and cost renders the degree unattainable to the sons of working men.

Mr. F. A. Willcox (Sunderland) said—It is with considerable hesitation that I venture to join in this discussion, for the reason that I am a new member, and it would be probably more to the credit of my modesty if I restrained my tongue. But I think I have some excuse in the fact that this question of technical education is of vital importance to our country, indeed, I might say it is not second in importance to the fiscal policy of Mr. Chamberlain! I would follow those who have already spoken in extending to Mr. Wurl my thanks for his able and instructive paper. I only wish I had had the opportunity of reading this paper some two years ago. It would have saved me an immense amount of reading, a large amount of thought—always repugnant to an Englishman—and it would have saved some of my friends the trouble of reading a good deal of dry correspondence. I first became interested in German education as the result of spending some six months

in the United States, engaged in technical work, at the time of the Boer war. During those six months I was subjected to the jibes, sneers, and worst of all, the sympathy of our American cousins on the decay of Great Britain, and more especially the decay of those industries which depended for their continuance and development on scientific education. It is a poor man who cannot stand up to jibes and sneers. What made them bitter was the fact that there was an element of truth in them. I got little consolation on reaching these shores, for the first thing I noticed on reading the papers was that eminent engineering firms on the North-East Coast and elsewhere were buying licenses from the Germans and others to show them how to make economical heat engines, both in the shape of the steam engine and the gas engine or direct combustion engine.

I can give you an example: Steam engines made to use high temperatures and moderate pressures, and gas engines which have been designed and perfected by the Belgians, Germans, and others for using blast-furnace gases directly, instead of burning them under boilers. I do not pretend to be able to give you a lecture on engineering, I am no more entitled to do that than was the late Lord Armstrong at my age; but one thing appears clear to me—the developments in the manufacture of these engines are due to the applicati n of the second law of thermo-dynamics. Again, take the case of locomotives. Within the last few weeks the neering journals have given descriptions of locomotives German States Railway which use superheated temperatures. Now, if the chief object to be design of a locomotive is to ma the most ec fuel in converting it into wor from the locomotives compared with th lar de wet steam, it would appear th erhea motives are the greatest adv mot recent years.

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If we except Hero of Alexandria, we may claim for Britons the invention of the steam engine both for stationary and locomotive purposes, and we may also claim to have taken a great part in the discovery and development of the laws of thermo-dynamics, which indicate clearly the path to follow in order to improve the heat engine in its most important function, viz., to convert fuel into work with the maximum of efficiency.

Unfortunately, having proceeded so far, we have rested on our oars and allowed others to make the costly experiments and undertake the vast amount of work necessary in order to apply these principles to practice, with the result that we are now reduced to the position of buying the experience of others in order to make economical heat engines.

In entering upon the correspondence on technical education to which I have referred, I wished to find out how the men were created in Germany and elsewhere who not only understood scientific laws but were also imbued with the spirit of enterprise to apply these laws to practical work. That is to say, men who had sufficient spirit to expend vast sums of money and a great amount of time, as they must have done, in perfecting these inventions. I think Mr. Wurl has given us some indication of the method by which these men have been produced, and in their production two forces have been at work: one, the excellent system of education, the other, the appreciation of the value of educated men by the employers. The stagnation in our country is equally due to absence of both these stimulants.

I will now turn to the diagram which has been so ably prepared by Mr. Spence, and points out some differences in the educational systems of Germany and England. If I might make a suggestion to Mr. Spence, it would be to raise the maximum age in that part of the diagram which refers to public schools, grammar schools and high schools, from 16 to 17 years. Most boys in these schools leave not at 16, but at 17, and a good many of them remain until they are 18 years of age.

Well, now, we have had lately in our elementary and secondary education an attempt made in the recent Education Act to codify that branch of education, and there is no doubt the codification will lead to great improvement.

What I would rather refer to is to the public schools, grammar schools, and high schools. It is in these schools that a radical change should be effected. It astonishes me that Englishmen have for such a length of time tolerated the system of education which exists in these schools. First of all, let us look at the staff of these schools, and consider who is responsible for the curriculum taught there, and also for the

method of teaching. In all these endowed schools, grammar schools and public schools, the man who decides the curriculum is the head-master. The man who is responsible for the method of carrying it out is the head-master. He is under no authority from Government or anyone else. Look at the German schools. In the Gymnasium and the Oberrealschule they teach from one standard set by the Government. The result is that you have boys coming out at the end of their course in regard to whom you know perfectly well what their education has been, and the value of it. And the curriculum has been arranged by the majority of the nation as being that to give the best results for their own country. Well, now, in our grammar schools you will find the curriculum which is taught will depend largely on the head-master. If he is a Cambridge man, he will teach for the Cambridge locals; if Oxford, for the Oxford locals; if London, for the London matriculation; if he holds some other degree, for the College of Preceptors or some other examining body. The result is, when a boy leaves school, it is almost impossible for an employer to form an opinion of the nature and value of his training, and often the training is of such a nature as to be useless to him in after life. Formerly, there was another great disadvantage attached to these schools, namely, the unwritten law that the head-masters should be either clerks in holy orders or priests of one sort or another. I do not wish to disparage the priest in any way. I think the priests as a class are men worthy of the highest esteem. That is to say, I think they are excellent men for the purpose of propagating Christianity or any other belief, according to their own lights, and they very often lead self-denying lives and bring comfort to their poorer brethren; but I do say they are the very worst class of people to be entrusted with education. The more one reads of the history of intellectual development, the more one is convinced that any advance made has been obtained by breaking down the opposition of the clerical party or the priesthood. But whether priest or layman, it is entirely wrong that the head-master should have the power to decide what curriculum should be followed in any school. That should be decided by a government department and should be planned on lines to give the best results for the country in general.

Again, the method of selecting the assistant masters has not a tendency to induce the best men to enter the profession. If a man wishes to become an assistant master he usually applies to a scholastic agency, which he has to satisfy as to his religious, moral and educational qualifications. Should he succeed in doing this he is favoured with notices of vacancies for which he may apply, and, if successful, pays to the agency a commission on his salary. But the question of obtaining a post ultimately rests with some head-master whose requirements he can supply. It is the nature of the qualifications demanded by some of these gentlemen which are highly objectionable. I have seen forms of application on which such questions as, "Are you a Churchman"? "How often do you communicate"? etc., have been asked. These questions amount to a religious test, and might have been seemly in the Middle Ages, but at the present time no man has the right to ask such questions, and no self-respecting man would answer them; and it is highly questionable whether a man who has complied with such tests has the necessary moral strength to assist in developing in youths an honest, straightforward character, the first object of education. Again, both in obtaining posts and advancement it is unfortunate that a preference should be shown for men holding Cambridge and Oxford degrees. This may be accounted for by the fact that the majority of head-masters are Cambridge and Oxford men. It may be an advantage to fill the chief posts in our public schools with graduates from these Universities, but judging by the complaints made by the professors of our technical colleges against the quality and quantity of the education at these schools, the infusion of new blood might not be a disadvantage.

The Board of Education has done a good deal towards remedying defects in this branch of our educational system, but it will never be a credit to the country until it is made a branch of our Civil Service, in which both the appointment of masters and the selection of a curriculum will be in the hands of the Government.

Well, now, I said a good deal of our decadence as a nation of manufacturers and inventors has been due to the apathy of our manufacturers with regard to employment of

trained men. We have many men in this country who have obtained an education equivalent to that given in the Hochschulen in Germany, but it is quite impossible for such men to obtain employment. This is the more astonishing when we remember that the invention and development of the steam turbine has been accomplished by a man of this type, and we can quite understand, when Mr. Wurl tells us that there is a demand for such men in his country, why that country has made such rapid progress in engineering science.

The discussion on the paper was closed, and Mr. Wurl's reply adjourned until next meeting.

NOTES ON THE CONSTRUCTION OF STABILITY CROSS CURVES FROM BALANCED PAPER SECTIONS.

By JOHN H. HECK, Member of Council.

Read in Newcastle-upon-Tyne, on Friday, January 22nd, 1904.

The centre of gravity and area of a surface or a number of surfaces can be readily found by means of a small model and a light lever balance; it can also of course, as is well known, be obtained by hanging the body from two points and weighing it.

The first method gives the result more quickly, with great precision, and numerical accuracy.

By the aid of a few models it is quite easy to make clear to almost any one what causes a ship to be stable, still there are many who own, sail or work ships who know nothing at all about the simple laws which govern the stability of a ship.

In the years 1885, 1886 and 1887 the writer read papers on the subject before the Institution of Naval Architects, the one in the last year giving a new method of using paper sections for obtaining stability data. One model only was required for all angles and displacements, as, however, it was immersed in water at the various angles and draughts, it had to be made watertight, and this caused expense in time and money.

Recently a number of paper models of known form, so that the displacement and righting arm could be rigidly determined, and also models of actual vessels were tested, the centre of gravity and displacement given by the balance being compared with the data obtained by actual calculation and the integrator.

The results of the trials of the models of three different vessels are given at the end of the paper; they are a fair sample of the tests made on five different vessels of varying size and shape.

The cross curves and drawings of the S.S. "A" and P.S. "B" were kindly given to me by Mr. Archibald Denny, the well-known shipbuilder; the S.S. "A" is a vessel of good size, having erections; the P.S. "B" is only a small steamer, having fairly fine lines (see page 103).

The S.S. "C" is a large passenger steamer, the cross curves of which were calculated some years ago by my colleague, Mr. Bernard Laws, it is also perhaps of interest, as results are also given of the righting arms obtained by using Tchebycheff's 9 ordinate rule (see page 104).

The models tried were made of ordinary drawing paper, they were formed in some cases of purely vertical sections (see Figs. 3 and 4, Plate III.), in others of what may be termed horizontal sections (see Figs. 6, 7, 8, 9, 10, Plates V. and VI.), and again by a combination of vertical and horizontal sections (see Fig. 5, Plate IV., and Figs. 7, 8, 9, 10, Plate VI.).

The latter plan was found to give very good results so far as accuracy was concerned, entailed the smallest amount of snipping or cutting, and as the models are not destroyed in the weighing for the different draughts or displacements, the righting arm and the corresponding displacement for same can be found or tested at any time.

In all the sections a centre line was drawn at the required angle and through the assumed centre of gravity, two slits about $\frac{1}{2}$ inch long and 4 inches apart being cut by a pen knife in the centre line of the sections in order to fix or keep them in position on the drawing board of the balance; the slits were found to be useful in self-centring the sections.

The sections employed were those usually got by dividing the length of the vessel by ten intervals.

Quarter sections, Nos. $1\frac{1}{4}$ and $10\frac{3}{4}$, were used at the ends in lieu of the two ordinary half-sections, Nos. $1\frac{1}{2}$ and $10\frac{1}{2}$. Fig. 2 (Plate III.) is an illustration of the body plan employed.

In all cases it was considered that the trapezoidal rule was quite near enough when employed in the longitudinal direction.

In order to enable the same kind of paper to be used for the end sections, Nos. $1\frac{1}{4}$ and $10\frac{3}{4}$, they were sometimes combined in the vertical models into one section, as shewn in Fig. 3 (Plate III.).

By the employment of the horizontal model or sheets, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$—

or any intervals could be used, and any variations in the length of erections could be easily taken into account, as it was only necessary to make the interval proportional to the length.

In the vertical models, paper sheets were used having a line passing through the assumed centre of gravity, and to the required angle, and in addition a number of lines drawn at right angles, spaced apart to the various desired draughts of water.

In snipping or cutting off the various pieces from the vertical sections so as to get the weights for the lesser draughts, a small portion or appendage, about ½ inch wide, containing the upper centring hole, was left on (see Fig. 4, Plate III.) for the purpose of fixing the remainder of the models on to the balance and as the arms of the balance were in the ratio of 2:1 a correction of one-half of the appendage was put into the scale pan and not included in the weights required for determining G.Z.

Where any sections were not deep enough to be kept in place by the projecting French nails on the drawing board, they were attached to the others by a few daubs of gum. Very little use of gum, however, was required in any of the cases, as the models here present will show.

In vertical models, by having sheets of prepared paper, with lines drawn on for the various angles and draughts, it was found possible to prick off at one time all the sections required for the different angles; the plan, however, of using part horizontal and part vertical sections, although it took more time, was found to be more accurate, took less cutting and forming of models, and did not entail the destroying of the models.

Figs. 6, 7, 8, 9, 10 (Plates V. and VI.) is a plan of such a model at 60°, consisting of five sheets, giving spots for five different points in the cross curve. In place of Fig. 6 (Plate V.), Fig. 5 (Plate IV.) could be used.

In the stability body plans, circles were drawn (see Fig. 2, Plate III.) with C.G. as centre, the radii of the circles corresponding to the various draughts at which data was required.

In the horizontal models, sheets of prepared paper were employed, the centre line in all cases passing through the assumed centre of gravity; in addition, lines at right angles were also spaced apart to correspond with the various draughts or layers of water as marked by the radii of the circles on Fig. 2.

The form of the vessel in all cases at the different sections

and layers was pricked off from the body plan, on the intervals Nos. 2, 3, 4, etc., and also on the half-intervals, as clearly shown by Figs. 7, 8, 9, 10 (Plate VI. and see Note *b*, page 102), each sheet thus showing the true vertical shape of the vessel at the various sections corresponding respectively with the different displacements or layers of water, A, B, C, D, E.

The models, although made in different ways, if cut out and put together would in all cases have formed the body plan of the stability sections.

The balance consists of a pine batten, A (Fig. 1, Plate II.), to one end of which a small horizontal drawing board, B, is fixed.

The batten is suspended 10 inches from the centre of the drawing board by a knife edge, C, working upon two small metal plates resting upon a support.

At 20 inches from the suspending knife edge another small knife edge, H, is fixed for hanging a small scale plan.

Two small French nails, F, 4 inches apart, project through the centre of the drawing board and serve to keep the models or sections in place.

A small sensitive spirit level, E, of ground glass is attached to the batten in order to show when the machine is balanced.

The weights employed consisted of a set of troy weights varying from 1 ounce to ·1 ounce, such weights, specially adjusted, can be bought at a cost of under three shillings.

In all the tests the unit of weight was ·1 ounce troy.

The models for small vessels were made to a scale of $\frac{1}{2}$ inch equal one foot and for large vessels $\frac{1}{4}$ inch equal one foot.

In the models made of vertical sections the displacement and righting arm was first determined for the maximum displacements and then for the lesser draughts by cutting away parts of the models.

In other models the displacement and righting arm was first determined for the minimum displacement and then for the deeper draughts by adding parts to the model.

To determine the righting arm and displacement:—

1. Place the model or sections on the drawing board, as shown in full lines in Fig. 1, and balance it by known weights.

2. Next turn the model or sections over on the other side, so that they are inclined in the other direction, as shown in dotted lines in Fig 1, and balance again by known weights, then evidently by the principle of the lever

(1) $\frac{\text{Difference of weights}}{\text{sum of the weights}} \times \text{constant} = \text{G.Z. or righting arm in feet.}$

(2) And sum of weights × constant = displacement in tons.

All the results in the tables (pages 103 and 104), viz., the displacement and righting arms were obtained by two such weighings.

The constant to this balance for the righting arm is respectively 40 and 20 for models made to a scale of ¼ inch and ½ inch to a foot and so on.

The constant for displacement depends on the scale of the model, the actual longitudinal interval between the stability sections and the weight of the paper.

For instance, a sheet of paper 10 inches by 10 inches would represent to a scale of ½ inch equal one foot a body of water

$$\frac{20 \text{ ft.} \times 20 \text{ ft.} \times \text{longl. interval in feet}}{35}$$

or to a scale of ¼ inch equal one foot a body of water

$$\frac{40 \text{ ft.} \times 40 \text{ ft.} \times \text{longl. interval in feet}}{35}$$

and so on.

If the paper is therefore weighed then the

$$\left.\begin{matrix}\text{Displacement} \\ \text{Weight of paper in units}\end{matrix}\right\} = \left\{\begin{matrix}\text{Tons of displacement per} \\ \text{unit of weight.}\end{matrix}\right.$$

The time required, without any assistance to make the models and to fix five spots in each curve for six different angles is twenty-four hours.

The writer personally has made the models and determined all the data for three angles in ten hours.

It is the making of the models that absorbs most of the time, when they are made the data can be got by the balance in six hours. The balance can be cheaply made and enables any one not having an integrator to construct curves of stability by the aid of a very few figures.

Description of Illustrations.

Fig. 1.—Balance used. (See Note *a*, page 102.)

Fig. 2.—Form of body plan used in making the models which are illustrated.

Fig. 3.—Vertical model at maximum displacement inclined at 60°.

Fig. 4.—Same model at minimum displacement shewing appendage.

Fig. 5.—Same model at minimum displacement with sections combined so as to reduce the number of sheets of paper, for example, Sections Nos. 6 and 7 are made of one sheet and so on; this form was generally used for the lowest draughts when horizontal models as Figs. 7, 8, 9 and 10 where used for the greater draughts.

Fig. 6.—Same model (as No. 5) at lowest draught formed of one sheet of paper.

Figs. 7, 8, 9 and 10 are the models respectively for the various greater draughts at which spots were determined.

Figs. 5, 7, 8, 9 and 10 form a full model and illustrates the plan adopted in the majority of cases.

Figs. 6, 7, 8, 9 and 10 form also a full model of the same vessel.

Fig. 3 is also a full model of the same vessel formed of vertical section.

(*a*) Note in Regard to the Balance.

The distance, 20 inches, on the top of the batten between the two knife edges is divided into ten divisions and each of the latter again into ten parts, very small weights are thereby dispensed with. Thus ·1 ounce on the No. 4 mark would represent ·04 ounce placed in the scale plan. Again ·1 ounce on the 5·1 mark would represent ·051 ounce placed in the scale plan. ·0005 ounce troy could be easily measured. F.F. small French nails for keeping models in position on board.

(*b*) Note in Regard to the Horizontal Models of the Layers B, C, D and E. (See Fig. 3, Plate III.).

Figs. 7, 8, 9 and 10 illustrate the combined cross sections of the horizontal layers B, C, D and E.

For example, Fig. 10 shows the vertical form of the vessel (of layer E, Fig. 3) at the various sections Nos. 1¼, 2, 3, 4, 5, etc., between No. 1 W.L. and No. 2 W.L., the centre line on Fig. 10 coinciding with the centre line passing through C.G. and marked T.T. on Fig. 3.

S.S. "A".

Angle.	Difference of G.Z. in decimals of a foot between values obtained by Integrator & Balance.	Displacement by Balance.	Angle.	Difference of G.Z. in decimals of a foot between values obtained by Integrator & Balance.	Displacement by Balance.
15°	·097	9,934	45°	·07	9,752
	·077	8,970		·0015	8,925
	·012	7,860		·028	8,034
	·007	6,720		·038	6,884
	·024	5,630		·056	5,682
	·08	4,608		·005	4,570
	·089	3,492		·094	3,450
30°	·0075	11,961	60°	·068	9,547
	·0174	9,890		·007	7,817
	·0089	9,082		·065	5,824
	·04	8,177		·04	3,777
	·0093	7,079		·083	2,351
	·0548	5,884			
	·142	5,216	75°	·023	9,562
	·125	4,602		·073	8,390
	·156	3,457		·079	7,161
				·005	5,841
				·00	4,809
				·044	3,850
				·1	3,226
			90°	·022	11,270
				·017	9,815
				·065	7,375
				·032	4,592

P.S. "B".

15°	·05	656	60°	·0445	Total Displacement.
	·075	499		·092	727
	·078	328		·12	670
	·07	174		·098	641
				·11	603
30°	·005	Total Displacement.		·096	471
	·09	734		·12	421
	·013	695		·12	320
	·03	650		·12	220
	·08	596			
	·073	537	75°	·05	Total Displacement.
	·055	472		·098	706
	·014	402		·12	647
	·082	331		·097	577
	·084	260		·085	497
				·07	406
45°	·055	689		·087	309
	·075	649		·08	220
	·082	603			
	·053	557	90°	·015	Total Displacement.
	·06	504		·013	699
	·015	450		·083	638
	·07	390		·017	567
	·075	331		·025	395
	·08	273		·0	300
				·006	217

S.S. "C."

Angle.	G.Z. by Integrator in Feet.	G.Z. by Balance in Feet.	Difference in Feet.	Displacement by Balance.	G.Z. by Tchebycheff's 9 ordinate Formula.	Remarks.
20°	·46	·6	·14	13,510	·38	
	·53	·64	·11	11,365	·43	
	·646	·6	·046	10,590	·48	
	·775	·85	·075	9,283	·64	
	1·05	1·079	·029	7,954	·88	
	1·221	1·225	·004	7,332	1·05	
	2·01	1·96	·05	5,460	1·83	
	3·64	3·633	·007	3,265	3·37	
30°	1·24	1·397	·157	13,542	1·18	
	1·28	1·426	·146	11,316	1·13	
	1·53	1·585	·055	9 202	1·38	
	1·975	1·918	·057	7,225	1·8	
	2·585	2·496	·089	5,437	2·36	
45°	1·92	1·863	·057	13,824	1·82	
	2·43	2·407	·023	10,974	2·36	
	2·71	2·7	·01	8,250	2·6	
	2·69	2·633	·057	5,699	2·68	
	3·06	3·033	·027	3,565	2·9	
60°	1·43	1·496	·066	13,509	1·27	
	1·98	1·9	·08	10,977	1·94	
	2·54	2·58	·04	8,479	2·56	
	2·94	2·88	·06	6,059	2·85	
	2·74	2·716	·024	3,991	2·55	

S.S. "C."

SPECIMEN SHEET OF DATA.

Angle.	Troy Weight. W = Greatest Weight.	Troy Weight. w = Least Weight.	S = Sum of Weights = W + w.	D = Difference of Weights = W − w.	G.Z. $= \frac{(W - w)}{(W + w)} C$ / Difference / Sum × Constant.	Displacement (W + w) C' = Sum × Constant.	Remarks.
					Feet.		
30°	8·825	8·222	17·047	·603	1·397	13,542	At C.G.
	7·376	6·8695	14·245	·5065	1·426	11,316	3 ft. below C.G
	6·021	5·563	11·584	·458	1·585	9,202	6 ft. below C.G.
	4·765	4·33	9·095	·435	1·918	7,225	9 ft. below C.G.
	3·635	3·209	6·844	·426	2·496	5,437	12 ft. below C.G.

After reading the paper, Mr. Heck explained the method by means of a working model.

DISCUSSION.

Mr. F. H. ALEXANDER said—I am sure we must all have been very much interested in this paper, and in the excellent explanation of the instrument on the table.

The number of methods of calculating stability is legion; I do not think there is any calculation which can be performed in so many ways as that of finding the righting arm of a ship's stability when inclined. A great many methods may be found noted in Sir Edward Reed's large work on the subject, and since that was written, as many more have been invented. It is probable that the tedious nature of the calculations has led to this variety, and to the use of experimental methods such as the one before us; but the seeking for new methods generally ceases when an integrator is available. Among the experimental methods are those which make use of a model of the vessel, or a contracted model consisting of thin cross sections of wood, or even paper, as in Mr. Heck's earlier work, these models being inclined in water. Mr. Heck now reverts to the use of sections representing the underwater part of the ship only and the method he suggests seems thoroughly practicable. I would like to ask him whether he ever tried a substance called "Willesden paper," which was advertised about the time of his earlier experiments?

Mr. HECK—No; ordinary drawing paper.

Mr. ALEXANDER—Because I think you would have found it answer your purpose. I used it for model boats and other purposes, and found it waterproof when immersed for short periods.

Mr. HECK—I have written to a great number of paper makers, all over the country, and they tell me they cannot actually produce a waterproof paper.

Mr. ALEXANDER—I do not think the paper is still in existence; possibly it proved a failure when subjected to severe or prolonged tests. It was said at the time to be suitable for building sheds and small houses. Mr. Laws's calculations were

referred to in the paper as having been made with Tchebycheff stations. I would like to know whether they were made from radial ordinates, or by the integrator?

Mr. HECK—I believe by the integrator, on sections spaced accordingly.

Mr. ALEXANDER—Thank you. Referring to the name "horizontal sections," I think it is a little misleading. It did not at first convey to my mind the arrangement shown in the diagrams and on the table. Would not a more correct term be "combined cross sections of horizontal layers."?

Mr. HECK—Yes.

Mr. ALEXANDER—Each of these jagged pieces is a portion of a cross section in a given layer?

Mr. HECK—Yes, on a layer at different intervals.

Mr. ALEXANDER—It struck me that another possible way of using the balance would be to make truly horizontal sections of the vessel, all parallel to the surface water plane at a given angle of inclination. I fear, however, that the labour of drawing out these planes for each inclination would more than balance the advantages.

Mr. HECK—That would take time, too.

Mr. ALEXANDER—It would, however, be possible to get a value for a righting arm as soon as a very few sections were made for an inclination. It must have occurred to many besides myself that a simple improvement on the instrument might be to have a rotating table, so that you would not have to lift off and replace the paper sections in order to get the second balancing. In nearly all the methods of obtaining the values of "GZ," or the righting arms, there is one great disadvantage. As the actual position of the centre of buoyancy is not determined, but only the distance between the two vertical lines of force, we are unable to readily apply the results to a vessel of similar form which differs in the ratio of beam to depth.

A former member of ours (Mr. Hök) in a paper read before the Institution of Naval Architects, in 1893, described a method of applying the usually obtained results to such a case, but it involved the calculation of the dynamical curve of stability; and other methods have been made use of for standardizing the results for this purpose. In most of our ship calculations, it is possible to deduce an approximate formula, or a co-efficient, when we have done a sufficient number of examples, but stability curves are somewhat baffling in this respect. If Mr. Heck could provide us with a ready means of obtaining both co-ordinates of the centre of buoyancy from some convenient axes, our labour in determining the probable form of the curves would be greatly reduced.

With regard to the accuracy of the results obtained by the instrument before us, I must say they rather surprise me. When we note that the maximum difference seems to be about ·1 of a foot, and that this is a deviation of centre on a linear measurement of perhaps 40 or 50 feet, I think you will agree that is it remarkably small. I should not be prepared to admit that the experimental values were incorrect, and the integrator ones correct. Either might be equally near the true value; and as it seems possible to use sections made to a larger scale with the apparatus shown, than with an integrator of ordinary size, it is possible that more accurate results might be obtained by the former. I think our thanks are due to Mr. Heck for bringing to our notice such a method of calculating stability, and for the labour he must have spent in bringing it to its present stage.

Mr. JAMES THOMSON said—I have listened to this paper with great interest. I have had to make a good many stability calculations, and my experience has been that very often one's time is limited, so that one has to work all day and all night. The methods of calculation given in text books—such as Barnes's methods—need a great deal of arithmetical work. I have made stability curves by simply cutting out sections of a piece of card and balancing them on the point of a needle, thus getting the centre of buoyancy. I do not know whether Mr. Heck could tell us whether his balances get more correct results. I should expect his to be more correct.

Mr. HECK—The comparison is given in the tables (pages 103 and 104).

Mr. THOMSON—It struck me from the figures quoted in the paper that this method has got as much accuracy as there is any necessity for. Practically it is not necessary to get the position of centre of buoyancy very exactly. One never knows the position of centre of gravity in a ship very closely. Even if an inclining experiment is made the day the ship goes to sea, the position of the centre of gravity will be altered in a day or two by the consumption of coal. I have listened to this paper and looked at the model with great pleasure, and I am sure it will be very useful.

Mr. H. M. MACMILLAN said—I have listened with very great pleasure indeed to Mr. Heck, particularly in the second part of his paper, when he was explaining the model. The paper itself, like all of its kind, from the very number of figures that get marshalled together is perhaps rather dry and the facts not readily grasped, especially by one reading it as I did for the first time to-night, but when we see this very simple and interesting model we forget the dryness of the subject. I do not think it is necessary to say much about the merits of the method; they are absolutely self-evident. The model and method is a rigorous graphical expression of the principle of moments. The sections are simply turned from one side to the other, the difference of moment is measured by the different weight required to balance the scale, so we have at once all the information necessary to solve the problem of the value of the righting lever of the ship at that angle, as Mr. Heck has so clearly shown. Mr. Alexander indicates what he considers improvements. I do not think they would be—any of them, always remembering Mr. Heck's main idea underlying this method. They are very interesting, but I think Mr. Heck's particular desire is a saving of time by adopting this method and I fancy that by the time a series of equidistant parallel water lines were drawn at the inclined angle and horizontal sections made from them as Mr. Alexander suggests it would be nearly time that the investigation was completed.

Mr. ALEXANDER—I am quite with you. I saw that as soon as I saw the instrument.

Mr. MacMillan—Also as to turning round the table. The table would have to be turned round exactly the same amount each time and it would have to be fixed quite centrally and be perfectly homogeneous and the pivot would have to be fairly hard and work perfectly or wearing would soon take place, all tending to introduce inaccuracies and to the complication of the instrument; and that introduces an objection I would have to this method altogether but solely on the score of accuracy. Unless the paper is very homogenous, and unless the slits which take these pins are very small, inaccuracies are liable to occur. Mr. Heck has checked several vessels' calculated value of GZ by this method and it is important and satisfactory for us to note that the two results are not materially different. I notice that the greatest difference recorded between the experimental and the calculated value does not exceed 1½ inches and probably this difference is not all against the model. I should think, however, that if heavier paper than we have seen used to-night could be obtained, of a uniform density, the personal errors of observation, etc., would be of even less moment in the result, being a practically constant quantity. Mr. Heck's method requires very little experience or knowledge to employ and adopt, and I think all calculated methods of stability do require a good deal of supervision. I can trust junior draughtsmen, and even apprentice draughtsmen, to do a complete stability calculation if they have a similar ship to follow, but if anything out of the common has to be allowed for it is rather liable to be omitted or forgotten or incorrectly evaluated. So I think this is a method which should be advocated and perhaps adopted by those firms who have not got an integrator. Like Mr. Alexander and Mr. Thomson, I remember with pain the time it used to take us to make a calculation with those formidable preliminary and combination tables of the wedge method, which were things to shudder at, and it is somewhat surprising to find the time it took us to employ the simple device of moments and areas adopted in the "cross curve" method which I think is now almost invariably used. I find a junior draughtsman can do a whole ship's calculations in from two to three working days with the integrator, and that not by Tchebycheff's rules, but by holding to Simpson's. However, this method is most interesting and simple, and it has the

advantage of being apparently sufficiently accurate for ordinary practical purposes. I think our thanks are due to Mr. Heck for the admirable manner in which he has explained it.

The PRESIDENT—Mr. Heck's papers are always interesting, always well received, and always excite good discussion. This discussion will now be adjourned until our next meeting on February 26th. In the meantime I think we are all very grateful to Mr. Heck for his very interesting paper.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

FOURTH GENERAL MEETING OF THE SESSION HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY, FEBRUARY 26TH, 1904.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting held at Newcastle-upon-Tyne on Friday, January 22nd, 1904, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. W. G. Spence and Mr. J. C. Stirzaker to examine the voting papers, for new members, and the following gentlemen were declared elected:—

MEMBERS.

Kremesek, M. E. J., Engineer Draughtsman, 47, Storey Square, Barrow-in-Furness.

Nicholson, Charles Muirhead, Engineer Draughtsman, 67, Meldon Terrace, Heaton, Newcastle-upon-Tyne.

GRADUATES.

Driver, John William, Engineer Apprentice, 5, Waterville Place, North Shields.

Matthews, John William, Ship Draughtsman, 28, Mainsforth Terrace West, Sunderland.

Taylor, John Allibon, Engineer Apprentice, 1, St. Alban's Place, Tynemouth.

Talbot-Palmer, Edward, Engineer Apprentice, 150, Ellison Street, Jarrow.

NEW HONORARY MEMBER—LORD ARMSTRONG.

The PRESIDENT said—As you know, at present the Institution is honoured in having three honorary members of note on its roll, viz.:—The Earl of Glasgow, Lord Linlithgow and Sir William H. White. The Council recently decided to add to this number in the hope that Lord Armstrong would allow his name to be included. I have now the great pleasure of announcing that his Lordship has consented. We shall, therefore, have again the pleasure of seeing in our *Proceedings* the name of Lord Armstrong.

The announcement was received with great cordiality.

Mr. MAX WURL replied to the discussion on his paper on "Technical Education in Germany."

The discussion on Mr. J. H. Heck's paper on "Notes on the Construction of Stability Cross Curves from Balanced Paper Sections" was resumed and Mr. Heck replied.

Mr. B. C. LAWS read a paper on "Technical Education, in which Special Reference is made to the Admiralty System."

ld firm where he has enjoyed the privilege of workshop practice, [illegible] has made some special agreement with that firm.

Although German academical engineers have only one year's workshop practice they find a situation. The demand is there; but this demand is not created, as Mr. Alexander seems to think, by the fact that much research work is done, but on the contrary, research work is done because academical engineers hold important positions, and are convinced that such work is necessary. The number of engineers employed in experimental work is very limited. Such work is done now by nearly all the greater establishments, as well as by college professors, sometimes with the assistance of some of their students.

From the discussion I could gather that the four years' training in the Hochschulen is considered rather too long, and I dare say it will be too long for teaching a profession, but I tried to point out in the paper that the training of the Hochschule aims at more than teaching a profession. Of course, I must admit that the aims are not always attained. Many of the students when they leave the Hochschule are not of much use for practical life, either because they are not fitted at all for an academical career or because they have wasted their time at the Hochschule. You will say now, that these failures are due to the academical freedom. But I think if a youth does not attend his lectures because he is not sufficiently attracted by the subject of his chosen profession then his loss to engineering and science will not be great, and if he stays away from the lecture rooms he will make room for those who care to go. Academical freedom is only for academical men, and all the students have gone through a long course in the secondary schools, and have grown so old, that they ought to feel some personal responsibility. I freely admit that these schools very often fail to convince them—I do not say fail to teach—but fail to convince them that they cannot become engineers by simply staying at a Hochschule, or by picking up some knowledge here and there, just enough to pass the examinations. All engineers have to cope with nature, and nature cannot be deceived. She will not lift her veil to anybody not worthy of her, intellectually as well as morally.

The present effort of English engineers to raise the English system of technical education must be greeted with satisfaction

by every thoughtful man. I feel almost sure that English engineers will succeed in getting what they want, in creating a system by which the splendid mental resources of the English nation will be utilised in the best way, and by which the individual capabilities of the Anglo-Saxon race may be developed to their highest perfection—to the welfare of the English nation, and also to the growth and prosperity of our art of engineering.

The PRESIDENT said—Mr. Wurl's paper, and the excellent discussion that has taken place upon it, will add very much to the value of the *Proceedings* of this Institution, and we are all grateful to Mr. Wurl for his work. There is no doubt that the German educational system is capable of improvement, but I think Mr. Wurl has brought out in his paper that Germany is already setting about to improve it, and I think, perhaps, following to some extent the lead given by England, by endeavouring to make it of a more practical character. That Germany will succeed in this I have not the slightest doubt. There is one thought, however, with which we may console ourselves, and that is that England has been too busy doing things to educate herself in science as thoroughly as some other nations. Centuries ago she commenced to produce things, digging for tin at first, then for coal, making pumping machinery to drain her mines, then building ships, marine engines, locomotives, etc. In this twentieth century I hope we are turning over a new leaf. We must not leave this discussion and Mr. Wurl's paper without thanking him very heartily for his work, and I am sure you will all respond with ardour to the proposal I make, that the Institution's best thanks be accorded to Mr. Wurl for his admirable paper.

The motion was carried by acclamation.

RESUMED DISCUSSION ON MR. J. H. HECK'S PAPER ON "NOTES ON THE CONSTRUCTION OF STABILITY CROSS CURVES FROM BALANCED PAPER SECTIONS."

Mr. B. C. LAWS said—I am very glad to have the opportunity of making one or two remarks on Mr. Heck's paper. Mr. Heck, I think, may be considered a pioneer in the phase of stability with regard to mechanical methods in determining cross curves, and we only have to refer back to the years 1885-6-7 to learn of the beautiful methods which he then introduced for obtaining these curves. In those years he used with his apparatus a tank, and I think there must always have been some doubt in his mind with regard to the extent to which the accuracy of his results might have been affected by the absorption of water into the material of his models. In the present apparatus he seems to have overcome that difficulty. The first thing that we notice on looking at the apparatus is its simplicity of form and the accuracy of the results obtained; and I think Mr. Heck should be congratulated on the accuracy of these results, which he obtains with what appears to be very simple and crude apparatus. The only drawback, I think, to the use of this particular piece of mechanism is the time taken to complete a set of cross curves. A smart operator in the drawing office, working with six angles and five or six water lines, would take from six to eight hours, probably, from the time he starts his calculations until the curves are set out on paper. Mr. Heck takes longer than that, but I think probably the advantage of the apparatus is, that whereas the integrator has to be actuated by an experienced draughtsman, the apparatus Mr. Heck puts forward could be operated by a lad in the drawing office. There is only one other point I would like to speak about, and that is the simplicity with which the principles of stability are illustrated by this apparatus. It is simply a calculation of areas and

centres of gravity, and I think the apparatus itself could be very well adopted by all those who have the function of teaching the principles of stability in their schools and colleges.

MR. J. H. HECK'S REPLY.

Mr. JOHN H. HECK said—I do not think there is any need to say much in reply except to answer the few queries which have been put forward.

A small table has been tried as suggested in order to obviate the reversing of the sections or models. No saving in time, however, was found nor were the results so accurate.

If the centre of buoyancy is fully required as well as the righting lever it is only necessary to turn vertical models through an angle of 90 degrees and take two extra weighings.

Ordinary drawing paper is quite good enough, so far as uniformity of weight and thickness is concerned, to give fairly good results. With the early experiment thick paper was used, but experience showed that ordinary drawing paper, bought retail at 12s. per 50 yards, was suitable for the purpose required.

In the paper it is stated that 24 hours are required with horizontal model, or what has been called combined cross sections of the various layers, in order to get all the data for six angles and five draughts. With this plan the models are not destroyed in getting the result, and the models, if desired, can therefore be retried or retested at any subsequent time.

By the aid of prepared paper in batches of six sheets and the employment simply of vertical sections or models, the data can be got in considerably less time: the models are, however, in this case partly destroyed by the snipping away of the various layers.

In the earlier trials ordinary drawing paper was tested to ascertain if it was sufficiently uniform in thickness and weight for the purpose intended, models being made with sections of known form so that the results could be rigidly determined. As the tests were satisfactory, models were made of a number of vessels in order to ascertain the relative accuracy between the righting arms obtained by paper models and those arrived at by the integrator.

I have only in conclusion to express my thanks to the gentlemen who spoke on the paper and to those who attended the reading of it.

The PRESIDENT said—Mr. Heck is always interesting, always ingenious; and we have all enjoyed very much the opportunity of listening to his paper and studying his model. In closing the discussion I would suggest that we pass a hearty vote of thanks to Mr. Heck for his excellent paper.

The proposal was carried with acclamation.

TECHNICAL EDUCATION, IN WHICH SPECIAL REFERENCE IS MADE TO THE ADMIRALTY SYSTEM.*

By B. C. LAWS, Member, A.M.I.C.E.

[Read in Newcastle-upon-Tyne, on February 26th, 1904.]

Introductory.

In presenting this paper to the North-East Coast Institution, the author thinks that no apology is necessary in view of the fact that an excellent paper on "Technical Education in Germany" has already been read by Mr. Wurl in November last.

Bearing this in mind and also remembering that technical education in this country is very much in evidence just now, it is hoped that a recapitulation of some of the means by which a technical training is obtainable may be profitable not only to the student himself but to those also who have it in their power to enhance the aspirations of the young man aiming at some higher platform in his profession.

No subject deserves to attract so much attention as education, no matter to what phase of life the results of that education are to be devoted; and that particular phase peculiar to the engineering faculty is worthy of the most careful consideration with regard to those who occupy, or hope to occupy positions of importance in its ranks.

The various Acts which from time to time have been passed by our Parliament dealing with elementary education may be passed over to be discussed more perhaps from the political standpoint, and to be administered by the County Councils and other bodies having this question more within their province. What mostly concerns this Institution, however, is the education of the engineer.

* In this paper the author has used the designation "engineer" as embracing all those engaged in the design and execution of work relating to structures in general, except where special reference is made to the "Admiralty System of Training," in which the designation refers to "Marine Engineering."

On reflection one cannot but think that the engineer has generally speaking received meagre recognition in the world of science until comparatively recently.

The essentially practical man, who hitherto has more or less built up his fortunes unaided by scientific knowledge, has frequently derided the idea of education, and innumerable instances could be cited where it has been a positive disqualification for an applicant for a post to reveal that he held an educational diploma. In consequence progress has been retarded, and the rightful recognition of a place for engineering amongst the learned professions has been delayed.

Institution of Civil Engineers.

The Institution of Civil Engineers some years ago realised this, and has been occupied during the last fifteen years with the consideration of the necessary preliminary education and the scientific training of engineers.

Under the able guidance of Sir John Wolfe Barry, a past-president of that institution, aided by such distinguished authorities as Sir Wm. H. White, Professor Unwin and others, it is *now* compulsory for all wishing to become associated with the institution to show competency both in the theory and practice of their profession. A candidate for election as "associate member" is required to show either (*a*) that he has gone through a course of instruction in some university or college recognised by the council, and to have obtained a considerable degree of success at his examinations, together with proof of a sound practical training; or (*b*), having satisfied the council that he possesses the necessary practical knowledge, he is required to pass certain examinations held by the institution in the theory of his profession.

The result has been that many important teaching bodies have modified their curricula in order to bring the standard of their teaching into line with the requirements of the institution. This unquestionably has had a most beneficial effect on the engineering profession generally and has stimulated those aiming at higher positions. The Institution of Civil Engineers may therefore justly claim to have placed a hall mark on its members by its recent action in raising their status in the direction of education.

Universities and Colleges.

Simultaneously with this movement there appears to have been a general awakening in the country. Even at Oxford and Cambridge it has been suggested to exempt candidates for mathematics and science honours from taking Greek; and at Cambridge the chancellor has suggested that the whole system of studies, teaching and examinations should be overhauled.

The University of London, at present under the guidance of its eminent principal, Sir Arthur Rücker, has recently extended its wide field of action, and degrees in engineering may now be taken. It has now incorporated all the important teaching institutions within a certain radius, amongst which are included the best technical and science colleges in London, such as The Central Technical College, The Royal College of Science and University College; and while the high standard of examinations still remains, the great barrier to the engineering student, viz., the study of ancient languages, has been removed; thus affording similar facilities as regards graduation which has so long obtained in the Durham and Victoria Universities of England and the Scotch universities over the border.

Technical Schools.

Other institutions where technical instruction is given are unquestionably making genuine progress. Organisation that is really worth the name is perhaps still wanting, and a standardisation of the educational system is the thing to be desired.

The City and Guilds of London Institute and The Board of Education are doing a work in their day and evening schools which is of a far-reaching character, and are laying a solid foundation for higher instruction. Many of the best men who to-day occupy positions in the forefront of scientific thought may look back with pride to the knowledge they obtained at these schools.

Relative Value of Technical Education.

In claiming for engineers the highest possible recognition in the world of science, it must not be thought that the author desires to detract in any way from the value of practical experience,

The highest scientific training obtainable can never produce an engineer, unless the particular individual knows by intimate contact with the practical side of his profession how to apply or even modify, if needs be, his theory to meet all the demands.

Theoretical knowledge is in no sense a substitute for practical experience, but the two judiciously combined can alone make the man able and ready to cope with the intricate problems which from time to time present themselves.

Admiralty System of Education (History of Dockyard Schools).

Herein lies the secret of the success which has attended the system introduced into the Royal Dockyards by the Admiralty some sixty years ago by which they select their apprentices and train them for the higher duties of their profession.

In 1864 these schools were augmented by the Royal School of Naval Architecture and Marine Engineering at South Kensington, which nine years later was transferred to the Royal Naval College at Greenwich.

At Keyham an engineering college has also been established (1884) which primarily gives instruction to those who enter the Navy direct as engineers (students), and in 1887 the engineering school previously held on H.M.S. "Marlborough" was removed to Keyham.

Apprentices who enter the dockyards do so on the result of open competitive examinations held periodically (twice a year) by the Civil Service Commissioners. The age is from 14 to 16 years, and the subjects of examination are:—Algebra (up to and including quadratic equations), Euclid (first three books), arithmetic, composition, orthography, geography (likely to give place to elementary physics and chemistry), handwriting. Candidates are also subjected to a medical examination.

After entering on his apprenticeship a lad attends school some two or three afternoons and evenings per week for about ten months of the year, receiving instruction in various subjects (see Appendix A, page 133) and continuing his studies privately in the evenings. When not at school he is employed on work in the yard or shops, the time generally being divided between the several departments, enabling him to become conversant with all branches of his work.

Competitive examinations are held annually between the apprentices of the same year of service, when a certain number are selected, according to the percentage of marks obtained, to continue their studies at school in the following year. Those attending school for the first two years are included in the lower division and for the third and fourth years in the upper division. In this way the best—generally about four or five—apprentices who head the examination list are retained for the final or fourth year's course, including the study of professional subjects in the drawing office; at the termination of which a final examination is held between such apprentices in all the dockyards. Upon the results, the Lords of the Admiralty *usually* select a certain number to continue their study first at the Keyham College for one year, and afterwards at the Royal Naval College, Greenwich, for three years.

Inducements to study, such as increase of salary to apprentices are unknown in the Admiralty system. Those who do well succeed because they have a desire to learn; and are repaid by winning valuable prizes, on the results of the yearly examinations, with the prospect also of promotion to some official position. The tangible nature of these rewards is an incentive to the student, and a source of gratification in after years.

For apprentices who do not get beyond the lower division (two years' course) there are such positions as draughtsman, inspector, foreman, and overseer open. Those who proceed to Greenwich eventually receive appointment into the Corps of Naval Constructors or the Engineering Staff of the Navy, provided they obtain at least 50 per cent. of the maximum marks in each subject at the final examination, failing which they may be offered a less important position. If the total marks obtained is greater than 75 per cent. of the maximum for all subjects, a first class certificate is awarded, and a second class if less than 75 per cent. is obtained, the former carrying with it £15 a year more than the latter after one year's service.

In 1884 it appears a scheme of reform was introduced by which students of naval construction were to be entered direct into the Admiralty service, and which temporarily proved disastrous to the trained shipyard apprentice. This began to affect the Dockyard Schools in 1889. The upper and lower division courses of instruction were shortened by one year, and

the number of apprentices selected for study at the Royal Naval College was suddenly reduced, so that in this year (1889) two shipyard apprentices* were selected and in 1890 *none* were taken. The result was that apprentices, who had taken the full course, in several instances sat for scholarships, left the Admiralty service and proceeded to a higher course of study at one or other of our technical colleges.

Due to the dearth of engineers in the Royal Navy, the Admiralty now (1890) began to select engine works' apprentices for further study at Greenwich with a view to their ultimate appointment as engineers.

This scheme has apparently not been a success, and another has recently been formulated by which the old order of things (previous to 1889) is to be again established. These points will be made clear on referring to Appendix B (Plate VII.), showing the appointments and successes of former apprentices of the dockyard schools since the introduction of the Royal School of Naval Architecture and Marine Engineering in 1864.

It will be seen that from the year 1864 till 1888, there were at no time less than three apprentice students selected for study at Greenwich. From 1889, however, something like a state of confusion has existed—due to the introduction of what was then considered to be a scheme of reform—which reached its maximum first in 1890 and again in 1894 and 1895.

It is difficult to understand the attitude of the Admiralty in view of the fact that at this period there was a demand for augmentation rather than a diminution of the staff such as perhaps had never before existed. It undoubtedly was a source of great disappointment to those apprentices who had entered the Admiralty service and had studied with the hope of ultimately obtaining higher promotion.

For more than half a century the dockyard schools have trained primarily all the professional officers at the Admiralty and the dockyards, and have produced men who have filled various important appointments in all parts of the world.

At home the best firms have been, and are associated with the names of men who have passed through this training, while the chair of Naval Architecture at Glasgow University has been

* One of the fifth and one of the fourth year.

successively filled since its foundation by former Admiralty-trained men, and the highest positions in Lloyd's Register and the Board of Trade have been held by men from the same source.

One of the greatest monuments to the efficiency of these schools is our modern navy, which during the last twenty years has grown to such vast proportions, and which must remain for ever indissolubly associated with the name of Sir Wm. H. White, the late Director of Naval Construction. On reviewing the past records of these schools it is difficult to imagine what the results would have been had they never been founded, or even were their functions curtailed.

The positions of responsibility which have been filled so long and so well by men who have known what it is to have intimate contact with practical work, and have so faithfully fulfilled the great charges entrusted to them, would, under other conditions, be occupied by those who, emanating from more affluent surroundings, could command the influence necessary to secure them positions without the healthy competition which these schools have afforded and by which the best intellects have been brought to notice.

Concurrent practical and theoretical training such as this it is impossible to overestimate, and it appears to be the best solution to the question of the technical training of engineers.

While great credit is due to all who have so well maintained the honour of these schools it must not be forgotten that in a great measure the success attending the training, as in all instances of systematic instruction, must be largely attributed to those who have the responsibility of imparting the instruction.

The masters are selected by open competition and with perhaps a few exceptions have resulted in an Admiralty-trained candidate being successful often against highly trained men from our best universities and colleges.

From the beginning the schools have been run on the most economic lines both in point of the salaries paid to the teachers and of equipment of essentials necessary for the students. This may be readily seen by comparing the cost of upkeep not only with that of any other teaching department of the Navy, but with that of our technical institutions covering the same range of teaching.

With the recent appointment of Professor Ewing, F.R.S., as

Director of Naval Education it is hoped that the training of the young men in all departments of the service will be still further advanced. At the present moment he is engaged in the work of reorganisation where necessity requires it, and the energy already displayed by him is sufficient evidence of the important place which he considers these schools should occupy.

Courses of Instruction.

The syllabus of the courses of instruction at the Dockyard Schools, together with that at Keyham and the Royal Naval College is given in Appendix A (page 133).

It will be seen that at Keyham and at the dockyards the courses are practically identical except for practical work in Physics and Chemistry taken at Keyham. The author understands, however, that the introduction of practical work into the schools is now under favourable consideration.

Outside the Admiralty service, noble efforts have been made in the direction of education and various private firms have formulated schemes for their employees. Perhaps the longest established is that of the well-known firm of Messrs. Denny Bros., Dumbarton, by which they select their apprentices for the drawing office and other departments. An abstract from the rules of the Leven Shipyard (Denny Bros.) is given in Appendix C (page 133). The whole scheme may, in a word, be described as "liberal" and only further adds to the great name which this firm has acquired.

Mr. Yarrow's excellent scheme for admitting pupils into his works has already been included in a paper* recently read by Professor W. E. Dalby, M.A., and therefore need not be detailed here. It is, however, very gratifying to know that the best advantages are open to the sons of workmen entering the factory.

The Great Eastern Railway Company for some years has realised the value of technical education and has a scheme in force by which their apprentices are able to devote six months of the year to study, at the same time receiving their pay (see Appendix D, page 135).

The South Western Railway Company has also a scheme in

* *Proceedings Inst. Naval Architects*, vol. xlv.

full working order; and their young men are able to avail themselves of the day instruction at one of the best London technical institutes.

The schemes recently formulated by the educational committee of *this* Institution is one of which, when developed, they may have cause to be proud, and by offering such inducements as are contained therein they are building a foundation upon which a very substantial edifice of technical education for their employees may be constructed.

Technical Education in General.

Judging by its results, the Admiralty system would appear to be one of the most perfect examples of technical education this country has seen.

By supplementing the science work of the Board of Education with technical instruction, the City and Guilds of London Institute are doing a great service to the country; and to such men as Sir Philip Magnus we owe its great development in recent years.

Generally, however, many defects remain, which require remedy. There is need of a general standardisation of educational methods; and the introduction of a stage intermediate between the lower and higher grades of technical education which exist at present; so that the best talent may be brought to light regardless of the circumstances of the individual, and that the poor lad may at least have the opportunity to compete with those who are better placed.

By the aid of the scholarship ladder, coupled with perseverance, many of our best men have obtained eminence against odds, and with improved methods and increased facilities it will still more be possible to obtain the best talent, which in the past must very often have remained latent.

We had probably some of the finest teachers in the world, but they have been badly supported in most of our teaching institutions, and in consequence the students have had to be content with an insufficient amount of attention; our laboratories too were not altogether up to date.

Most of the branches of engineering are well represented in the majority of our technical institutions; naval architecture,

however, upon which the growth of this empire may be said more or less to have depended, has not been justly considered. Excepting the Royal Naval College, where a professional instructor is appointed from the Admiralty, and the chair of Naval Architecture at Glasgow University, no other separate chair in this subject appears to exist, and this in a country eminent for shipbuilding and marine engineering.

When we sympathise with education—and especially technical education—as America and Europe do, we shall be able to hold our own against our competitors. No effort should be spared to obtain every advantage that a high technical training could give, and the best opportunities should be afforded those who have the best abilities.

As with individuals, so it is with nations. The nation which wrapped itself in the cloak of its own thoroughness, had nothing but a poor future before it. Not many years ago we held an all round pre-eminent position, to-day we have relatively retrogressed; due principally to the bias of those who have clung to old traditions and have believed in old methods while other nations have propounded new ones and stepped ahead.

We had in the past taught other nations the secrets of the arts and manufactures; they have extended the lessons they had learned, have founded great institutions of technical instruction and encouraged research; and now it is our part to learn from them the best points in their schemes, and put them into force.

Technical Education in Foreign Countries.

With regard to the manner in which this question has been viewed and treated in other countries it may be noted that, in most continental states, with perhaps the exception of Germany and France, theoretical knowledge has been *too much* in evidence, and while the student of engineering has been well equipped with a large amount of theoretical knowledge he has very often had little or no practical experience of the machines or designs he has been studying. This state of things is to be deplored, and it is very satisfactory to find now, on the continent as at home, a tendency to the general adoption of laboratories and workshops in all the technical institutions to supplement the lectures.

The Engineering Congress held in Paris, 1899, was very unanimous in its opinion of the absolute need of well-equipped laboratories as a part of technical instruction.

Of the European states Germany perhaps holds a leading position with regard to the development of the education of engineers. One good point in the system there in vogue is that a student must have had *some* practical experience before he may enter for his first academic examination. Particulars may be seen in Mr. Wurl's paper* on "Technical Education in Germany."

In France the spirit of development in educational matters has also been very much alive, and schemes by which it has been sought to bring about improvements have been adopted. One such scheme† may be cited here.

In 1882 a school in connection with the Northern Railway of France was founded exclusively for the benefit of the sons of the employees.

Entrance is obtained by competitive examinations held every year under the supervision of the chief engineer. The number of pupils average forty, they enter at from thirteen to fifteen years of age, and take a course of tuition extending over three years. There are no fees and all books and tools are supplied. The subjects taught are: Arithmetic, geometry, geography, French language, physics and chemistry, engine construction and drawing, with a practical training in locomotive work. Periodic examinations are held, upon the results of which prizes and certificates are awarded.

Up to the present, about two-thirds of the pupils have been awarded certificates, and have mostly entered the company's service. Some have gone into the employment of other firms, but these have always the privilege of preference over all other candidates should they afterwards wish to re-enter the service of the company.

In America this subject has received very full attention, and the author thinks that a great deal of the means adopted in the United States could be profitably studied in this country. For some thirty years America has been working out the higher education of engineers and there is sufficient testimony in her well-equipped colleges that a long-felt want has b su

* *Proceedings N.E.C. Inst. of Eng. and Shipbuilders,*

† *Revue Générale des Chemins de fer*, July, 1900.

At Cornell University, for example, there is accommodation for some 2,000 students, who enter on passing an entrance examination of no great difficulty, and continue their studies for four or five years. On leaving at about 22 or 23 years of age a student is considered to have so developed in his practical and theoretical experience as to be capable of taking the reins of management of not unimportant works.

With reference to the system in vogue in foreign countries there is one very important factor, viz., that the required training may be obtained with much lower fees and less expenditure generally to the student than in Great Britain; which doubtless has had the effect of sending so many British students abroad—especially to Germany—to pass through a course of study for which in this country their means would have been quite inadequate.

In Scotland, however, a more liberal view of this question has been taken than in England; there, a student is able to take a full course for what at the best colleges in England would hardly suffice for one session, and with the additional advantage that in the long vacation, during the summer months, he is usually able—due to the courtesy of the employer—to follow his profession in the shipyard, shops, or drawing office.

There is at the moment a general tendency on all sides to what may be termed a second revival of learning and it is hoped the present movement may break through that conservatism by which progress—at least in technical matters—has been so long retarded.

In conclusion, the author must express his sense of gratitude to those gentlemen who have so kindly given him particulars of the educational schemes in vogue outside the Admiralty service.

On taking a general glance at the situation, there would appear to be good cause for satisfaction at the liberal way in which this question of education has been and is now being promulgated in certain of our great departments of industry, and it may at once be inferred that on the whole we have made progress, and it is hoped that at no distant future this question may be placed on such a basis in this country as will ensure us at least a proud position amongst our competitors.

APPENDIX A.

Syllabuses of the Courses at (*a*) Dockyard Schools, (*b*) Keyham College, (*c*) Royal Naval College, Greenwich:—

(*a*) *Dockyard Schools:*—

(1) Lower Division (first two years):—All the fundamental principles of: Arithmetic and mensuration; algebra (to binomial theorem); geometry (whole of Euclid's elements); mechanics—statics, dynamics, hydrostatics, and graphic statics; trigonometry (to solution of triangles); physics—heat, and magnetism and electricity; chemistry (inorganic).

(2) Upper Division (third and fourth years):—The above in (1), together with descriptive geometry; higher mechanics (treated with calculus); higher trigonometry (summation of trigonometrical series); calculus (diff. and integ.), analytical conics (to hyperbola) and co-ord. geometry of two dimensions; physics and chemistry (taken to a higher standard); applied mechanics, strength of material and mechanism; pneumatics and hydraulics; dynamics of the engine; together with the study of professional subjects of shipbuilding and engineering and drawing office experience.

(*b*) *Keyham College:*—Same as at the Dockyard Schools, together with practical work in physics and chemistry, combustion and metallurgy, workshop and shipyard appliances, and practice, design.

(*c*) *Royal Naval College, Greenwich:*—As at Dockyard Schools and Keyham College, taken to a higher standard, together with special lectures on various subjects of professional interest.

APPENDIX B (See Plate VII.).

APPENDIX C.

ABSTRACT.

Rules of the Leven Shipyard (Denny Bros., Dumbarton) *re* apprentices for the drawing office:—

1.—When an opening occurs in the drawing office for the admission of an apprentice, it will be filled up by competitive examination, according to the following rules.

2.—This examination will be conducted by Professor Lambert, of the Royal Naval College, Greenwich, who has kindly undertaken this duty; and the candidate whom he decides upon as having the highest total of marks will be the one selected for entering the drawing office.

3.—The examination will be advertised at the gates of the yard, engine works, forge, and foundry, and in the local and Glasgow newspapers.

4.—Candidates must not be under 15 years of age, and must show good certificates of health and character, on forms which will be supplied on application. They must also supply certificates giving the name of the school they have attended, and the progress they have made in the various subjects, along with a certificate from the teacher that their attendance and conduct has been satisfactory.

5.—Shipyard apprentices who desire to compete for the drawing office examination must, during their apprenticeship, have attended a course of study prescribed by the Educational Committee, and they must not have been absent during the regular working hours for more than two hours in thirty except with the written consent of their foreman, or through ill-health, certified by a medical man. They must also supply the certificates mentioned in paragraph 4.

6.—The subjects of examination will be:—

(*a*) Mathematics, including arithmetic; geometry (first two books of Euclid), algebra, to and including simple equations, and logarithms.

(*b*) Theoretical mechanics, as required for the elementary stage of the Science and Art Department.

(*c*) Practical, plane, and solid geometry, as required for the elementary stage of the Science and Art Department.

(*d*) Freehand drawing.

(*e*) Mechanical drawing.

No candidate will be admitted who does not obtain 50 per cent. of the maximum number of marks, and in each subject he must make at least 35 per cent. of the marks.

7.—Successful candidates, who have previously served at least one year in this yard, will be retained in the drawing office for an apprenticeship of four years, being paid at the rates of £30, £40, £50, and £60 for each successive year.

8.—Successful candidates who have not previously served one year in this yard as apprentices, will be retained in the drawing office for an apprenticeship of five years, being paid at the rates of £20, £30, £40, £50 and £60 for each successive year.

Further, in Dumbarton there are bursaries which entitle the holder to a three years' course at the University of Glasgow. If a lad, on winning one of these, decides to go in for the shipbuilding or engineering course (winter session), he may work 2 or 3 summer sessions in the shipyard, and the last part of his apprenticeship in the drawing office. The time spent at the university counts towards his apprenticeship.

The ordinary drawing office apprentice is encouraged and helped to take advantage of evening classes in order to further the theoretical knowledge of his profession.

APPENDIX D.

GREAT EASTERN RAILWAY.

NOTICE TO EMPLOYEES IN THE LOCOMOTIVE, CARRIAGE AND WAGON DEPARTMENT.

The Directors of the Great Eastern Railway Company desire to give increased facilities to their employees for the pursuit of technical study, and subject to the following conditions have agreed to grant to employee-students leave of absence with full pay for one or more winter sessions of about six months each.

Conditions.

1. An employee-student shall not be less than 18 or more than 20 years of age on July 1st of the year in which the session for which leave of absence is granted commences.
2. He shall have been at least three years in the service of the Great Eastern Railway Company, regular in attend-

ance and industrious at work, and shall have given satisfactory evidence of his practical ability.

3. He shall have attended the classes at the company's Mechanics' Institute during at least two sessions, and shall be able to produce certificates from the Committee of the Institute that he has attended such classes regularly and worked in a satisfactory manner.

4. He shall be required to pass a local examination, which will embrace the following subjects, or produce certificates from the Board of Education (or in the case of railway carriage building, the City and Guilds of London Institute), in the subjects and stages named, such certificates to have been obtained in the current or during the preceding year.

The local examination will be held in the month of May. Applications to sit thereat must be made to the head of the department not later than the 25th April.

(*a*) Machine construction and drawing (advanced stage), or railway carriage building (honours stage), or building construction (advanced stage); (*b*) practical, plane and solid geometry (elementary stage); (*c*) mathematics (second stage); (*d*) steam (advanced stage); (*e*) applied mechanics (advanced stage); (*f*) theoretical mechanics, solids and fluids (elementary stage); (*g*) magnetism and electricity (elementary stage).

An employee-student who complies with these conditions must make application not later than August 1st of any year, and must submit for approval to the head of his department a scheme of the course of study he proposes to pursue. He will also be required to give satisfactory evidence by a monthly report, or by such other proof as may be required, that he is industriously working to the approved scheme.

In addition to the course of theoretical study, the employee-student will be required to devote a portion of his time to visiting manufactories, works in progress, etc., for which visits facilities will as far as possible be obtained. It is estimated that not less than one such visit can be made each month. A report of the visit must be submitted to the head of the department during the following week.

The leave of absence with pay will be cancelled in the case of any employee-student who fails to fulfil the necessary conditions or whose conduct is in other respects unsatisfactory.

JAMES HOLDEN.

Locomotive, Carriage, and Wagon Department,
Stratford, E.
March 16*th*, 1903.

ESTABLISHMENT OF PRACTICAL CLASSES (IN CONNECTION WITH THE G.E. RAILWAY MECHANICS' INSTITUTION), TO BE HELD DURING WORKING HOURS AT STRATFORD WORKS.

Arrangements have been made for practical classes in the following subjects to be held in the works during the ordinary working hours:—

1. Tensile and other tests on iron, steel, bronze, copper, etc., in the test house.
2. Taking indicator diagrams from steam engines, etc.
3. Experiments with model link motion.
4. Setting valves on a locomotive.

Employee-students who fulfil the following conditions will be allowed to attend these classes without loss of pay.

1. The student shall be between the ages of 17 and 21, and shall have been not less than two years in the service of the Great Eastern Railway Company, during which time he shall have been regular in attendance, industrious at his work, and have made satisfactory progress.
2. He shall have attended the classes at the company's Mechanics' Institution during at least two sessions, and shall produce certificates from the Committee of the Institution that he has attended regularly and worked in a satisfactory manner.
3. He shall either have passed in the advanced stage or, having obtained elementary certificates, shall be a student in the advanced stage of three of the following subjects:—Machine construction and drawing,* steam, applied mechanics, theoretical mechanics, solid geometry.

* The City and Guilds Examination in railway carriage build y be substituted for machine drawing.

In addition he must have obtained at least a first-class certificate of the Board of Education in the first stage of mathematics, or must submit himself to a local examination to prove that his knowledge of mathematics is sufficient to enable him to benefit by the instruction to be given.

He must at the same time be attending such classes as the locomotive superintendent considers desirable.

A student attending these practical classes will be required to take notes upon and to work out for himself the results of any experiments which may be made in the classes. These notes and calculations must be submitted for inspection from time to time, and unless they shew evidence of attention and application the student will be disqualified for further attendance at the classes.

The number of the classes and the selection of the subjects will in all cases be decided by the locomotive superintendent.

Employee-students, qualified as above, desirous of attending the classes, should make application on a form to be obtained at the Works Manager's Office not later than Wednesday, 3rd February, 1904.

JAMES HOLDEN, Locomotive Superintendent.

Locomotive, Carriage and Wagon Department,
Stratford, E.
January, 1904.

DISCUSSION.

The PRESIDENT said—I am sure we must congratulate Mr. Laws upon his most excellent paper, and I hope it also will produce a good discussion.

Mr. ARCHIBALD HOGG said—Mr. Laws has given us a description of the Admiralty schools, and of Messrs. Denny's encouragement, etc., but I should have liked to have seen him go further, proposing for instance, something which might be done here on the Tyne for the improvement of the present drawing-office staff. It is hard to understand why he has brought forward the paper unless it is to express the hope contained in the second paragraph, namely, "It is hoped that a

recapitulation of some of the means by which a technical training is obtainable may be profitable not only to the student himself but to those also who have it in their power to enhance the aspirations of the young man aiming at some higher platform in his profession "—a very good hope, and if it is in any way realized, Mr. Laws's paper will not have been in vain. The paper, however, except for the above sentence, seems to lean in the direction which all recent discussion on this subject has taken, *i.e.*, better technical education. Now it seems to me that too much stress is being put on this, and that the main means by which a man may know his business is being neglected. Of course, my remarks refer chiefly to shipbuilding. In this business it is only the practical men who are wanted, *i.e.*, those who know the ship in all its details, and who know at least enough to be able to design a beam exactly suited for the work to be done, and who know what loads, etc., to allow for; in short, a man who can think and invent, which is a thing no amount of technical education will put into most men. The only way by which good men can become acquainted with a ship is to work again and again in direct contact with each separate part, and every encouragement should be given to the draughtsman who should be allowed freely to go into the yard and on board the ships to see the several parts being made and put in place.

In the sixth paragraph Mr. Laws refers to the essentially practical man who, he says, has retarded progress. Of course, we have progressed; but all progress made has been through the endeavours of the practical men. If the progression has been retarded, it is due to his having to adhere to rules or rather tables of scantlings formulated by such societies as Lloyds, etc.

Mr. Laws talks of progress, but how can we practical men be expected to progress when a distinguished Institution like the Civil Engineers has been occupied, as Mr. Laws says, during the last 15 years, with the consideration of the necessary preliminary education and the scientific training of engineers.

No doubt Germany and America have great Institutions of technical education, but it seems to me that these are a source of unnecessary expense, and that it is very probable that the young man would become more quickly familiar with the ship

if his time was spent "correctly" in the shipyard drawing office, and that those who have the power to enhance the young men's aspirations would be better or more profitably employed in studying how to facilitate their labours than in helping to create unnecessary institutions of technical education.

This is perhaps proved by the fact that the "average" good draughtsman is only such after 15 to 20 years' experience under the present conditions.

It is necessary that the draughtsman should know the elements of statics in order to correctly proportion his work, and understand what he is doing, but surely this does not merit the building of huge Institutions all over the country.

If we fill up our drawing offices with college-bred men they would be like the sweep who stuck in the chimney—too big for the job. These men would take just as long to become good draughtsmen and probably more if you count the time spent or lost in the college, and then you have no guarantee that they will be any better or more useful than those we have. The question which appears to me to be most needful of consideration is how to improve the draughtsmen we have got, and how to train the apprentices.

In conclusion I might venture to remark that Mr. Laws has treated very mildly a subject of great importance. All this technical education is for the special benefit of the drawing office staff. Now, seeing that it will take 20 years before we can fill our offices with the technically educated draughtsmen—before they would be as useful as the men we have—I think what is wanted is more consideration for our present drawing office staffs and the adoption of some means of improving them and not to wait for 20 years.

Mr. W. G. Spence said—I do not know that I have very much to add to this discussion. I have listened to Mr. Laws's paper with very great interest. I think it fills a very useful function, and I certainly thank him for it. I must say I was much interested in listening to Mr. Hogg. His racy description was well worth hearing, and to tell you the truth when he got up I did not quite expect the line he was going to follow. It reminded me somewhat of Balaam. He got up, I thought, to bless the thing, and it was a somewhat qualified blessing.

There is no doubt a good deal in what he says, but I cannot say I agree with him. It is not only a question of training the draughtsmen we have at present, but you have got to train the men who are to come on afterwards. As far as engineering is concerned, I think the people of this district have put their hands to the plough. There has been a scheme formulated and given out on a broad general basis, which each firm can adapt as it cares, and I hope very soon we will see that scheme in operation in this district. I am referring to the engineering side. I do not know what they are doing in the matter in shipbuilding. Several things struck me as of great interest in Mr. Laws's paper. For instance, he speaks of the Institution of Civil Engineers having introduced a system by which they require examination. I know as a matter of fact that this has produced an effect among young civil engineers. I know one place in London where the young men are working hard to pass this examination, and previously that was not so much the case; and I know the coming engineers themselves value that examination. I can speak of one particular case of a man who had a very brilliant scholastic career, who has had a very extensive practical experience, and when this rule was introduced he thought it worth his while, although then an associate member of the Institution, to go and sit the examination, and he did so. A very striking commentary on that followed shortly afterwards. He had to produce his credentials as an engineer. He stated that he was an associate member. These were submitted to a gentleman who has had a very distinguished engineering career and the first question he asked was whether he was an associate by examination or otherwise. He was told by examination, and he said, "You had better put that down; that makes a great deal of difference to my mind." That shows you the value that some of the senior engineers put on the examination. Later on Mr. Laws speaks of the want of organization throughout the educational systems of the country. That was a point largely dealt with in the discussion on Mr. Wurl's paper, and I think there was a general feeling that organization was wanted very much. Then, speaking of the relative value of technical and theoretical instruction, Mr. Laws makes the remark that "theoretical knowledge is in no sense a substitute for practical experience, but the

two judiciously combined can alone make the man able and ready to cope with the intricate problems which from time to time present themselves." It seems to me rather sad that at this time of day it is necessary to make that remark. I quite agree with his making it, but I think it is rather a sad commentary that we need to make such a remark at the present time of day. Then Mr. Laws goes on to describe the Admiralty system. Personally, I had never before known very clearly what the Admiralty system was, but, after reading it, I must say I have a great admiration for it. The great merit of it is the system of gradual selection and the survival of the fittest. They begin with a big mesh and sift down till they get the best—until at the end there are one or two boys out of a large number who proceed to the highest attainable course. I think that is the right system, and on the right lines, and I have certainly been very much struck with it. Mr. Laws speaks, too, of the country schools. It struck me in reading Denny's rules, personally I have a great feeling for lads brought up in the country taking to engineering, and I know—I was at a country school—that a great many parents in the country probably would send their sons into engineering if they knew how they could get them into the works; I believe a great many excellent lads are lost to engineering simply through their parents not knowing exactly how to go about it. Denny's system of advertising is a good one, and if the recommendations of our Educational Committee could be made known throughout the country districts, that lads having specially good educational qualifications, and who have been the top boys in different schools could get admission into works, I believe we would often have applications from these lads and find them very much above the average. It would be rather a difficult thing to do, possibly, but still I think it could be done. Then Mr. Laws speaks of the advantage of the scholarship ladder. Well, that is an important thing, and I know it is a matter of a good deal of conversation among and the wish of many of our members that this Institution may some day be associated with a scholarship in engineering. Personally, I hope this may be so. Further on, Mr. Laws mentions that in the systems on the continent they have gone rather too much in, perhaps, for purely educational work, and says, "it is very satisfactory to

find now, on the continent as at home, a tendency to the general adoption of laboratories and workshops in all the technical institutions." I agree with him in the introduction of laboratories for experimental purposes, but the time the youth is a student at a college or technical school is so short that his mind is far better employed in being broadly educated—that is, being taught to think, and confining himself to study. Any technical work he does I think should be purely in the way of experimental work in laboratories, no workshop practice. The latter, I think, can be better taught in shops. In other words, I think to begin teaching workshop practice in technical institutes is much the same as to teach a woman dressmaking by giving her lessons in cutting out dolls' clothes. Later on Mr. Laws speaks of the cost of education in England. The difference between an English and Scotch university is marvellously striking. You pay in a Scotch university a sovereign or a guinea as a matriculation fee, and the only other expenses are class fees which are very moderate. I have listened to the paper with great interest, and thank Mr. Laws for it.

The PRESIDENT said—I desire to make one remark in regard to Mr. Hogg's statement. Mr. Hogg appears to have entirely mistaken the purpose of this technical education agitation. The purpose of it is to avoid filling the drawing office with the men Mr. Hogg objects to so much. Have college-bred men if you like, but college-bred men of the right kind. We do not want them because they have failed at other things. The object of the whole scheme is to keep such men out altogether. What is wanted is the young man who is a born naval architect or a born engineer, and who has the industry and enterprise to properly qualify himself to fill a position in the drawing office whether taken out from among the ordinary apprentices or not. The engineering side do not allow a lad to go to the drawing office who has not been in the works. In the shipyards it is not an uncommon thing for a youth to be in the drawing office who has had absolutely no workshop practice at all and never will have any. If that is not theoretical training I wonder what is?

Mr. HOGG—I think it is right to have good men in the office, but my point is this, that the average draughtsman at present in the drawing office can stand a lot of improving.

The PRESIDENT—Oh, yes; I quite agree with you.

Mr. HOGG—And what I consider to be as necessary as the better education of future draughtsmen is some means of encouraging those men we now have to make themselves better.

The discussion was adjourned, and the meeting dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

FIFTH GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON WEDNESDAY, MARCH 9TH, 1904.

J. H. HECK, ESQ., MEMBER OF COUNCIL, IN THE CHAIR.

The CHAIRMAN expressed his regret that the President, Mr. Tweedy, was unable to be present that evening owing to ill-health.

The SECRETARY read the minutes of the previous general meeting, held in Newcastle-upon-Tyne, on Friday evening, February 26th, 1904, which were confirmed by the members present and signed by the Chairman.

The discussion on Mr. B. C. Laws's paper on "Technical Education, in which Special Reference is made to the Admiralty System" was resumed.

Mr. F. H. ALEXANDER read a paper on "Longitudinal Engine-room Bulkheads in Merchant Vessels, in Relation to Transverse Stability when Bilged."

RESUMED DISCUSSION ON MR. B. C. LAWS'S PAPER ON "TECHNICAL EDUCATION, IN WHICH SPECIAL REFERENCE IS MADE TO THE ADMIRALTY SYSTEM."

The SECRETARY read the following communication which he had received:—

22, STRACEY ROAD, STONEBRIDGE PARK,
LONDON, N.W.

DEAR MR. DUCKITT,

The value of technical education as a national and business asset has of recent years come to be recognised amongst the more progressive members of the engineering profession. Its value, however, is not so generally accepted in this country as is desirable, and practical engineers do not seem to be taking full advantage of the benefits to be derived from having men in their employ who have been scientifically and technically trained. There has been a very common mistake made in the past by practical men expecting too much from the young man fresh from college or the technical school. Similarly, the young man has made the mistake in imagining that because he had been technically and scientifically trained he therefore is a fully qualified engineer. The value of technical training can only make itself felt when supplemented by experience. It is time that it came to be recognised that a scientific and technical training does more than supply the recipient of it with an abundance of facts and theories, for, in addition, if rightly and rationally acquired, it gives a broader and yet more critical outlook, a keener sense of the relationship of facts, and enables him to rightly and effectively co-ordinate his experiences. In other words, technical training is not only a banisher of ignorance, but also a mental stimulus; and the test of its utility is not how much it performs of itself, but how much more, when allied to experience, it enables a man to take advantage of his experiences. The chief difficulty to be met, however, at the present time, is not to convince ourselves of the utility of scientific and technical education, but how it can be acquired most efficiently from the point of view of the engineer.

Of all the systems that have yet been suggested none seems to be more excellent than that brought forward by Mr. Laws in his valuable paper; not only from the point of view of the training it provides, but also because of the opportunity it gives, without the interference of artificial barriers of class preference or distinction, for the survival of the fittest. In the first place the system demanded a fair standard of excellency with regard to general training. Secondly, it has the advantage that the students, while learning their scientific principles, are every day meeting with object lessons, which enable them to appreciate the practical bearing of those principles, and no doubt in after years have also the very necessary effect of enabling them to recognise the limits of application of pure theory. Further, it enables those who are worthy and have made sufficient progress in theory, and after having had a measure of practical experience, to give their whole time for a few years to the acquirement of an advanced knowledge of science and its application to the branch of engineering in which they are engaged. And this is important, as it enables those who are most likely to profit by that instruction to devote their undivided attention to the mastery of the difficult problems presented, and to obtain a complete mastery such as it is almost impossible to acquire after a day of continuous occupation in practical affairs. Experience seems to show that youths coming into the science and technical colleges from the public school, who have had no practical experience—and many of whom are not the most likely to profit by the training—are not able to take full advantage of their opportunities because of their inability to appreciate the practical bearing of the instruction. On the other hand, many who entered the shops immediately after leaving school, and who, after several years' practical experience, go to college, are so poorly equipped—having largely forgotten their mathematics and knowledge of other sciences, if ever they had any—that they fail to fully profit by the college course, unless they are prepared to sacrifice at least four years, which is one or two years longer than most English students who have been through the shops are prepared to give.

A system such as that of the Admiralty solves the difficulty. One weakness of the Admiralty schools was undoubtedly the little attention given to sciences, viz.: physics, chemistry and

metallurgy, that did not seem applicable to the particular work the students of the schools were doing. But Mr. Laws hopes this is soon to be remedied. What seems to be required is that the nation shall ensure a properly organised system of elementary and secondary education up to the age of sixteen years. By a system similar to that of the Admiralty, or Messrs. Denny Bros., the engineers shall choose their apprentices, opportunities being given for study and instruction on certain days or half days, together with a reasonable amount of evening work during the winter months. Advancement to go by merit and industry, and ample opportunity for men of real ability to proceed to the technical college for a three years' course at least; after which, with two or three more years' practical experience, these men would prove of inestimable value to the community, if only our engineers and manufacturers would give them their chance.

Some time ago a friend of mine was travelling in Germany. One day, in the train, he noticed a young man wearing a medal, which evidently was a mark of honour or distinction. Making bold to inquire from the young man the significance of the medal, he was informed that it was a mark of the distinguished position he had taken in one of the leading German polytechnics, in the bridge and structural design classes; and he was wearing it because that day he was visiting several firms who had written to him immediately the results of his success had been made known, offering to take him into their employ. He intended to choose the position which would prove the most lucrative to him, and which offered the best opportunities for the exercise of his abilities.

In England I have often known young men who have distinguished themselves in a similar way refused employment time after time, even though willing to work for very little remuneration. A young man, whom I know very well, carried out a research in one of our technical schools about two years ago, and made one or two discoveries which were likely to lead to a commercial success in electrical engineering. Not being able to continue his research at the college, for financial and other reasons, he communicated his results to several English firms and asked them to take him into their employ. All refused. He wrote to a well-known American firm, which immediately paid his expenses to America and gave him every

opportunity of continuing his research, and at the present time he is working in the States with this particular firm. Who shall say that in such instances as these we have not in large measure the key to the success the Americans and Germans are meeting with in the commercial world?

Yours faithfully,

F. C. LEA, A.M.I.C.E.

Mr. JOHN H. HECK said:—I have listened with much interest to the paper Mr. Laws has given us. There appears to be a general opinion amongst those who have read it that it has come at the right time, and is a valuable contribution on the subject to the literature of this Institution. The paper is a clear and succinct *précis* of what this country has done or is trying to do in the matter of technical education. Mr. Laws has been of service in drawing attention to the system of Admiralty schools and the benefit they have conferred, not only on the apprentices who have served their time in the dockyards, but on the country generally; and judging by the results the money spent on the schools has been a very good investment indeed for the nation. Concurrent practical and theoretical training is the basis upon which the Admiralty system is built, and in the paper the opinion is given that it appears to be the best solution to the question of the technical training of engineers. There are many who think so too, and consider it quite as good as, if not superior to, any of the various systems employed on the Continent or elsewhere; and it is only necessary to peruse from time to time what is written on the subject to see that this view is growing, and the reason seems to be that the Admiralty dockyard schools have stood the test of time and given very satisfactory results.

Mr. Laws in his paper refers as an illustration of the efficiency of the dockyard schools, to Sir William H. White, who is so well known, not only in this country, but in many others by his book and scientific papers and for the good work he has done for the British Navy. His opinion carries so much weight with it that I should like permission to read a short extract from a paper which he has written on technical education, and which is published in the January number of *Techn*

Speaking of the Admiralty system he says:—

Elementary technical instruction is by common consent a necessity of any scheme of State-aided technical instruction. To devote attention simply to higher technical instruction, and to lavish resources upon it exclusively, or even chiefly, would be a fatal mistake in the national interest. We go abroad for examples how to carry on technical education, and we do well to understand foreign systems thoroughly and to profit by their experience, but there are some home lessons we are apt to forget. We need not go abroad to learn some things—we have them here already. It is a regular fact that for sixty years in this country—and I speak with full knowledge of what is happening abroad—the Admiralty has had in operation a system of technical training for dockyard apprentices which offers results more extensive and conclusive than any obtainable elsewhere. It has produced such men as Sir Edward Reed, Sir Nathaniel Barnaby, Sir William Pearce, Mr. Martell, and Mr. Waymouth, of Lloyds; the present managers of such great shipbuilding yards as Fairfield, Elswick and Clydebank; the manager of the engine works at Harland and Woolfs, the staff of Lloyds, the principal and subordinate officers in the Royal Dockyard and others. In fact, it is no exaggeration to say that this system has produced the majority of the men who are now occupying the most prominent positions in the shipbuilding industries of this country. These facts conclusively establish the merits of the Admiralty system. It has given to private shipbuilders its leaders, who have risen from the ranks, while it has produced men holding many important and influential positions in all parts of the world.

Sir Wm. H. White, further on in the same paper, states:—

The Admiralty system has produced men of whom England might well be proud. What the Admiralty has done, large employers can also do, though not perhaps to so great an extent.

In the paper, which deals with technical education in general, it is pointed out that defects remain which require remedy, so that the best talent may be brought to light regardless of the circumstances of the individual, and that the poor boy may at least have the opportunity to compete with those who are better placed. This, in my opinion, is one of the most important points touched upon in the paper. In order to be of real service to the nation, any youth who can show he is qualified, mentally, should have the opportunity of receiving technical instruction. The well-off young man can study when he likes. The poor boy at the present time has only the night; he therefore has great odds against him. Boys who have to get up early, work all day, and study hard at nights are not, in the majority of cases, able to take full advantage of any instruction they may receive, and I believe medical men would say that it is prejudicial to health for a young man to live under such conditions. Mr. D. Drummond, of the L. and S. W. Railway, who has introduced a system of day classes for the

apprentices at the works, is evidently of the same opinion, for in the February number of *Technics*, in an article on "Technical Education for Apprentices," he writes the following:—

> I am no advocate for evening classes as a means of technical education, though I fully recognise the enormous help they have afforded, and are still affording. I am satisfied that the strain, both physical and mental, to which a growing youth is subjected, is likely to be dangerous to his health, if he is taxed by evening classes after a day's work in the shops; and it is quite impossible for him to be in a condition either of mind or body to make satisfactory progress under such conditions. An exception may perhaps be made in favour of drawing classes, but for such subjects as mathematics and mechanics I am sure my remarks are true.

Those of the members who have had to work hard all day and have studied at night will endorse what Mr. Drummond has written.

In Germany and on the Continent there is conscription. In this country there is none, a very great advantage to enjoy, and this is one reason why Mr. Laws is not far wrong in writing:—"When we sympathise with education, and especially technical education, as America and Europe do, we shall be able to hold our own against all competitors."

In the paper reference is made to the healthy competition which exists in the Admiralty schools, and by which the best intellects have been brought under notice. We have an example of this in the annual competition amongst the apprentices at Messrs. Hawthorn, Leslie & Company for the Marshall Cup. Some of the apprentices work hard each year so that at the annual examination they may get a place amongst the first three on the list; and the rivalry is so keen that the relative merits and chances of the different competitors is discussed with much zest and interest. The institution of the Marshall Cup has done much to encourage and induce the best of the apprentices to study and work during their spare time.

In my opinion Mr. Laws has done good work in the interests of technical education by bringing his paper before the Institution.

Mr. Thomas Shaw said- I am sure we will all agree that our thanks are due to any member of this Institution who is so brave as to read a paper having for his subject "Technical Education," and confining himself to the United Kingdom.

After carefully reading the paper, we find that Mr. Laws in his wisdom prepares us for the fact that special reference is made to the Admiralty system, but he is practically compelled to confine himself to the training given in the dockyards for want of any other system to criticise or put before us. I quite agree with the general opening remarks, but entirely disagree with the statement that "elementary education may be passed over to be discussed more perhaps from the political standpoint." Whether the education is for an engineer or any other trade, it is necessary that the foundation or base must be well and truly laid, and elementary, secondary, and technical education be carefully dovetailed into each other, and made into a finished article with practical experience. I can quite understand an applicant who has been technically trained being disqualified for certain positions, but after consideration the objection or prejudice redounds to the credit of the training rather than otherwise. Let me cite an example. Suppose an employer requires a draughtsman to order material. The qualifications for this position are, that he must have a thorough knowledge of all types of vessel, the detail construction of same, must draw his plans with accuracy and expedition, also be conversant with the rules of the classification society, and regulate the sizes so that the material may be worked in the cheapest manner by the workmen in the yard. If, however, the prices are based on weight there is not so much necessity for the latter. The foregoing knowledge can only be obtained after a lengthened period in a drawing office, and any time spent in a technical school would only be wasted, as each firm must work material in the best manner suited to their plant. It therefore follows that the employer does not want a man in this position who is likely to receive promotion through his higher training in a technical school. *Vice versa*, if an employer wants a draughtsman to calculate the actual stresses coming into force on the different parts of the ship or the other higher calculation necessary for new types, he will be only too ready to avail himself of an applicant who has acquired a technical training, and so obtained a knowledge of the principles underlying such calculations, and which can be obtained in a technical college.

The Institution of Civil Engineers may have put a hall mark on their members, but the paper does not mention of their

having instituted any technical training. A pamphlet issued recently by the Association of Technical Institutions gives us some actual figures of what the other institutions mentioned by Mr. Laws are doing. The pamphlet embodies the results of enquiries as to the number of pupils at all the recognised technical institutions in this country. It shows that in about a hundred places of instruction there are only 3,873 pupils over 15 years of age who are taking a complete course of not less than 20 hours a week. Of these 2,080 are in their first year, 1,125 in their second, 555 in their third, and only 113 have attended more than three full years. The total number of third-year students in engineering is only 347 and of fourth-year students in this branch only 52, the majority of whom began their studies at the age of 15.

The Admiralty system is very lucidly and concisely put before us, and I think we must all deplore the fact that every boy, whether engaged in shipbuilding, engineering or other kindred trades, does not have the opportunity of that much-to-be-desired combination of practical and theoretical training. The number of brilliant men who have graduated through the dockyards is the very highest testimony we can accord to a system that is so admirable in all respects. I think it would have been very satisfactory if we could have had figures given to us, by Mr. Laws or anyone else, showing the cost of each student throughout the time he is taking the different courses, and let us know exactly what it costs the nation. If that information could be obtained it would be very valuable. It is not reasonable to expect private firms or even limited companies to equip technical colleges and give exceptional advantages to their apprentices unless they reap the reward. The instruction so given will probably accrue to the firms competing against them. This does not altogether apply to the dockyards, inasmuch as every student entering the higher technical schools must remain in a dockyard for seven years or pay a considerable sum of money to be relieved from the bond.

I should have liked Mr. Laws to have been a little more emphatic in stating that it is imperative for us as a nation to establish State-aided technical schools, worked in conjunction with elementary and secondary schools, and I lay special emphasis on the State-aided, as I consider that we, as a nation

would be amply recompensed for money so spent and should look upon it as one of our best national assets; and as the employers have awakened to the fact that it is absolutely necessary for a small percentage of their staff to have the best education, and are willing to allow their apprentices to spend part of their apprenticeship at college, there is no reason why we should not have State-aided technical schools in all large commercial centres.

Mr. H. M. Macmillan said—I do not want to offer many remarks at this stage of the discussion, especially as what I have heard of Mr. Shaw's remarks are in exact accord with what I intended to say; but there have been one or two points mentioned in the discussion as well as in Mr. Laws's paper which I should like to take up. I think the paper itself is a very concise epitome of the position of technical education in this country to-day and it gives me, at any rate, a good deal of information that I have often wished to have on the matter.

It is a very gratifying thing, I think, to see the position the authorities of the London University have managed to adopt in incorporating the leading technical and scientific colleges in and around London, and that degrees in engineering may now be obtained there. That, I think, is likely to prove a great factor in the standardization and consolidation of technical education throughout the country, and in this respect, at any rate, there is much room for improvement.

I am very much interested in the particular aspect of technical education that Mr. Laws's paper takes—I mean with regard to the Admiralty system—and, like the author and Mr. Shaw, I think it is only necessary to consider the long list of illustrious names of men who have had the advantage of that training to realize the great importance and advantage of such a training to any one connected with shipbuilding or engineering. One of the speakers does not appear to think a very elaborate technical education is necessary in the shipyard or engine works. I am afraid my opinion is quite at the opposite extreme to that. I do not suppose the greatest discoveries in astronomy have been made by the men who wanted to navigate their ships quickly to get their freights to market; and yet the science of astronomy has done much for navigation; nor that Darwin originally studied

biology in order to cheapen the price of oysters, and yet that came about. And so on, we may go. It is perfectly absurd to judge of the value of any study by its obvious and immediate results; to do that, I think, would absolutely paralyse knowledge and degrade such an industry as engineering to the very lowest level. I quite agree with Mr. Laws when he says the support given by the authorities in this country to technical education is very meagre, and I think that applies not only to Government authorities, but to the powers that be in private concerns as well, and I suspect this attitude strikes very near the root of the matter. If we are really anxious to get lads from the professional classes into engine works and shipyards we must not only increase by a shilling or two their weekly pay during apprenticeship; whilst that is in every way commendable, and is likely to have excellent results amongst ordinary apprentices I do not think it is the sort of inducement that is likely to appeal with much force to what we are now calling the pupil class, whose parents are fairly comfortably off and can afford to give their sons a suitable training in their youth; either they themselves or their fathers for them are going to inquire into their material outlook *after their apprenticeship is finished*, and if a well-educated youth who generally has a considerable range of professions equally open to him thinks of entering engineering, unless he has a very decided *penchant* for it, he wants to know what he is going to get at the end of his apprenticeship. In connection with that matter I think we may look at the Greenwich Naval College course and see what are the prospects of the highly-trained men they produce compared with merely clerical individuals, both in the Government employment. The young man who goes through the Dockyard Schools, and by a rather severe process of weeding out finally goes through the Royal Naval College, and, by a still more severe process of weeding out gets into the Admiralty as a naval constructor, must have been a very brilliant lad indeed and he will be from 23 to 25 years of age. Probably Mr. Laws will put me right in this matter if my figures are not accurate—it is a good many years since I have had occasion to weigh up the pros and cons of the Naval College course—at the end of that time, after he gets into the Admiralty, I think he starts with the magnificent salary of £150 or £180 per annum. Mr. Laws mentions that

if he passes with a first-class certificate he receives £15 a year more than he would do otherwise, but I think he does not state what the figure itself is. When we compare that with the prospects of a youth who simply takes a classical or general education at one of the universities and goes in either for the first-class Home or the Indian Civil Service, particularly the latter, we see that whilst he need not be such a brilliant youth, nor have worked so hard, yet at the age of 22 to 23 he gets an appointment in India at a salary beginning at £600 or £700 a year and after about 20 years' service he retires with what to us poor ship-builders is the almost fabulous pension of £1,000 to £2,000 a year for life. There is nothing of that kind in the Admiralty for any unfortunate technical official. I do not suggest that the first-class clerks in the Government service are too well paid; they are not, for they must be and are men of good education and much more than ordinary ability, but I certainly consider that the corresponding technical officials are very much underpaid by comparison.

I would have felt grateful to Mr. Laws if he could have seen fit to have included in the appendix to his paper the detailed course of study at the Greenwich Naval College. It would certainly have been instructive and interesting in our future reference to this paper in the *Transactions*. I do not think this course of study is sufficiently known amongst students. For instance, I believe that any subject of the King can get into the Royal Naval College and sit for a scholarship every year. I believe this admits the student to free education at the Naval College and £50 per annum, and if he passes the examinations with the other naval students at the end of the three years' course, he can enter directly into the Admiralty as a Royal Naval Constructor. That is an inducement, I think, that not many students outside of the dockyard area are sufficiently familiar with. It would contribute to hard work on the part of the best apprentices if they knew that this possibility lay before them.

Talking of the merits of several educational institutions, Mr. Laws says they are getting more laboratories and workshops in several of the colleges. Well, laboratories are a very desirable adjunct to all scientific work, but my personal experience of school and college workshops does not lead me to think

LONGITUDINAL ENGINE-ROOM BULKHEADS IN MERCHANT VESSELS, IN RELATION TO TRANSVERSE STABILITY WHEN BILGED.

By F. H. ALEXANDER, Member.

[Read in Newcastle-upon-Tyne on Wednesday, March 9th, 1904.]

Calculations of stability under bilged conditions are not often required for merchant vessels, although they are occasionally made for the best classes of passenger liners; even then, they are usually confined to those which relate to the longitudinal stability (or trim), in order to determine such positions for the transverse bulkheads as will ensure the vessel's remaining afloat with one or more compartments open to the sea.

There are, however, certain twin-screw vessels in which a longitudinal centre-line watertight bulkhead is fitted between the engines, and provided with watertight doors which may be closed as usual from the upper deck. This bulkhead is apparently fitted for the purpose of keeping one engine room free from water in case the other gets flooded, and thereby enabling the vessel to steam with one set of engines. It is obvious that such flooding must cause the vessel to take a list to that side, and that this list may in some cases be so great as to render it impossible to steam, or may even endanger the safety of the vessel.

The object of this paper is to show the possible effect on the transverse stability of a ship, if one side of such an engine space were flooded, say, by collision.

The general principles which underlie all calculations of bilging are as follows:—

(1) The part of the vessel laid open to the sea no longer gives buoyancy, but is, as it were, removed from the hull (see Fig. 1, Plate VIII.).

(2) The vessel sinks deeper into the water until the lost buoyancy is replaced by new.

(3) The vessel comes to a position of equilibrium when the centre of buoyancy is in the same vertical as the centre of gravity, and the metacentre is above the latter.

A flooded compartment which extends from side to side of the vessel can be situated near amidships in such a position as to cause immersion only without change of trim; but if situated nearer to either end, its flooding will obviously cause depression towards that end.

It may be of interest, here, to show how the calculation of transverse inclination may be made with approximate accuracy of result in cases where the angle reached is small. The same method, slightly modified, is the one usually adopted for dealing with the trim, because in the latter case the inclination seldom exceeds 5 degrees.

Fig. 2 (Plate VIII.) shows a cross section of a vessel in the upright position. Let WL represent the position of the waterline before damage. Now, if an empty compartment amidships be flooded at one side, the buoyancy in way of this compartment is lost, and the "effective waterplane" becomes of form similar to that shown in Fig. 3 (Plate VIII.).

If no inclination were to take place the vessel would sink bodily to the waterline, W_1L_1, so that the volume between the effective planes, WL and W_1L_1, makes up the volume of buoyancy lost up to WL.

This volume of lost buoyancy, divided by the area of the mean effective plane between WL and W_1L_1, gives the distance, S, or "sinkage." It is usual, however, to calculate S by using the effective area of WL.

$$S = \frac{V_L}{(\text{feet})(A - a)} \text{ where } \begin{cases} V_L = \text{volume of lost buoyancy below WL (cu. ft.).} \\ A = \text{area of complete plane WL. (sq. ft.).} \\ a = \text{area of plane in way of damaged compartment (sq. ft.).} \end{cases}$$

Passing to the determination of the angle of inclination, there are several steps to take, viz.:—

(1) Find the position of the axis, NN, through the centre of gravity of the effective waterplane, W_1L_1 (see Fig. 3, Plate VIII.).

(2) Find the moment of inertia of this effective plane about the axis NN.

(3) Find the position of the centre of buoyancy, B_1. (This is the centre of buoyancy of the upright vessel floating to W_1L_1, but excluding the part in way of the damaged compartment. See Fig. 2, Plate VIII.).

(4) Find the vertical height of the metacentre, M_1, above the centre of buoyancy, B_1.

(5) Find the angle between this vertical and a line joining M_1 and G (the position of the centre of gravity of the ship). This is the angle of inclination required.

Using the following symbols:—

A = area of complete waterplane, W_1L_1 (sq. ft.).
a = area of ineffective part (sq. ft.).
$(A - a)$ = area of effective plane (sq. ft.).
x = distance between centre line and axis, NN (feet).
d = distance between centre line and centre of a (feet).
h = transverse width of a (feet).
I = moment of inertia of A about centre line (sq. ft. × feet^2).
I_1 = moment of inertia of $(A - a)$ about axis NN. (sq. ft. × feet^2).
Ia = moment of inertia of a about the centre line (sq. ft. × feet^2).
B = centre of buoyancy of upright vessel before damage.
B_1 = centre of buoyancy of upright vessel after damage.
B_2 = centre of buoyancy of inclined vessel after damage.
M_1 = metacentre of upright vessel after damage.
g_1 = centre of gravity of volume of lost buoyancy, V_1.
g_2 = centre of gravity of volume of effective layer between WL and W_1L_1.
g_1g_3 = vertical projection of g_1g_2 (feet).
g_2g_3 = horizontal projection of g_1g_2 (feet).
V_D = volume of displacement (cubic feet).

We may take the steps in order thus:—

(1) $x = \frac{a}{(A - a)} \times d.$

(2) $$I^1 = I - \{I\alpha + (A - \alpha)x^2\}^*$$

(3) $$BQ = \frac{V_L}{V_D} \times g_1 g_3$$

$$B_1Q = \frac{V_L}{V_D} \times g_3 g_2$$

(4) $$B_1M_1 = \frac{I_1}{V_D}$$

(5) The angle of inclination, $B_1M_1G_1$, may be found by construction or

$$\tan \theta = \frac{PG}{M_1P} \qquad \text{(Fig. 2, Plate VIII.).}$$

Now $PG = BQ$ and $M_1P = M_1B_1 - PB_1$ of which

$$PB_1 = GQ = GB - BQ.$$

The inclined waterline, W_2L_2, should be drawn through the centre of flotation, c (at the distance x from the centre line).

The above method may be regarded as giving a sufficiently accurate result where the angle does not exceed 10 degrees, but greater angles may be over-estimated up to the point at which the deck edge becomes immersed, and seriously under-estimated beyond that stage.

When a bilged compartment contains water excluding material, the buoyancy of this material must be taken into account, and it is usual to make an allowance either by calculation of the buoyant volume, or by taking a derived percentage of the volume of the compartment. The machinery in an engine room may be estimated to exclude from $\frac{1}{7}$ to $\frac{1}{5}$ of the volume of the water which would fill the compartment up to the level, WL (Fig. 2, Plate VIII.). In calculating the trim no great error will result if this buoyancy is assumed as spread evenly throughout the space occupied by water, but in transverse calculations, an estimate of its centre is desirable. This matter is referred to again towards the end of the paper.

When a side engine room is flooded, change of trim takes place as well as transverse inclination, but the former is not usually of such excessive character as to cause important change in the transverse curves of stability, should the latter be calculated disregarding such change of trim.

* N.B.—$\frac{1}{12}ah^2$ is the value of $I\alpha$ about the centre line when a is of rectangular form: this approximation is often sufficiently correct for practical purposes.

Fig 4 (Plate IX.) represents a cross section of a bilged vessel inclined to an assumed angle and floating at a waterline, WL, the shaded portion is a section through the water-filled part of the engine room. Let G be the centre of gravity of the ship, and GZ the righting arm of the stability curve for the undamaged ship if floating at the waterline WL (Z being on the vertical through the centre of buoyancy, B). Let l represent the position of the centre of volume of the water-filled part, and lg its distance from a vertical through G. Then for a volume of displacement which excludes the water-filled part, the righting arm, GZ, may be found by the usual principle of moments:—

$$GZ_1 = \frac{(V \times GZ) - (v \times lg)}{(V - v)}$$

Where V = volume of whole vessel up to WL and
v = volume of water-filled part.

When the values of GZ_1 have been determined for a sufficient number of assumed waterlines and inclinations, we can construct a set of cross curves of stability for the bilged condition, similar to those usually constructed for the unbilged; and from these cross curves we can obtain the curve of stability for a given displacement in the usual manner.

I now proceed to give the results of some investigations which I have made as to the nature of these curves. The calculations were made for a vessel of the following dimensions:—

Length between perpendiculars	680 ft. 0 inches.
Beam moulded	74 „ 0 „
Depth moulded to upper deck	45 „ 0 „
Draught (even keel)	30 „ 0 „
Displacement	27,900 tons
Block coefficient	·647

A general outline sketch is given in Fig. 6 (Plate X.), showing an open side from forecastle to poop, the type being similar to that of many ocean liners. Figs. 7, 8, and 9 (Plates X. and XI.) show curves of stability for certain heights of GM; and assuming the bilged engine room to have certain percentages of the length of the ship.

The centre of volume of the flooded part was in all cases assumed to be at $\frac{3}{10}$ of the ship's length from the after perpen-

dicular. The effect of the flooding upon the trim may be exemplified by one case. Assuming the compartment to be 10 per cent. of the ship's length, and neglecting the effect of transverse inclination, the draught aft became 33 feet 5 inches and forward 29 feet 2 inches.

Referring to Figs. 7, 8, 9 (Plates X. and XI.), the ordinates are the lengths of righting arms at each inclination when above the base line and of upsetting arms when below it. The angles at which the curves cross the base line are those at which the ship would come to rest in smooth water if allowed to settle slowly. When the stability curve lies entirely below the base line all arms are upsetting ones, and the vessel would turn over; or at best would be dependent on the watertightness of the erections above the freeboard deck to prevent her doing so. No allowance was made for such erections in these curves, but those shown in Figs. 10 and 11 (Plate XII.) were calculated upon the following assumption:—The vessel was considered as plated up to the promenade deck, giving a moulded depth of 53·5 feet, instead of 45 feet, and the watertight bulkheads were also carried up to this deck, but as the vessel inclined, water was assumed admitted to the bilged compartment above the second deck as well as below it.

The great value of the extra freeboard is at once apparent, but there is not to my knowledge any passenger liner which has such a freeboard, combined with the fitting of the longitudinal bulkhead. The German high-speed Atlantic liners, which have almost continuous erections, have a long opening in the side, abreast or just abaft of the engine rooms, and most of them have also a well abaft the forecastle. One of the latest of them is, however, provided with a few thwartship watertight bulkheads above the freeboard deck.

The length of the engine compartments in vessels now in service varies from about 8 per cent. to 13 per cent. of the length between perpendiculars and there is one case at least in which it exceeds 15 per cent. The G.M. of these vessels when loaded is hardly likely to exceed 2 feet; it is more probably between 1 and 2 feet and may be less than 1 foot in some cases. The proportions of beam, depth, draft and freeboard, and arrangement of open side, are not in many cases widely different from the example for which the curves in Figs. 7, 8, and 9 (Plates X. and XI.) are

given; and it cannot be said that these curves are reassuring. If we take for example, an engine room of the 10 per cent. size, and 1 foot G.M., we find (Fig. 7, Plate X.) that if allowed to settle slowly enough such a vessel would come to rest in still water at about 33 degrees' inclination; but would be dependent upon her deckhouses for any further stability, or failing their buoyancy would turn over. Even if the G.M. were 2 feet (see Fig. 8, Plate XI.) and she came to rest at 23 degrees' inclination, the stability curve she would have, between 23 degrees and 54 degrees, can hardly be called satisfactory, seeing that its range is only 31 degrees and its longest arm is only ·65 of a foot.

The case referred to, in which the length of the engine spaces exceeds 15 per cent. is that of one of the most recent Atlantic liners, and it should be noted that a thwartship bulkhead is fitted as well as the longitudinal one, thus making four engine rooms. It would, however, be quite possible to have this thwartship bulkhead so damaged as to admit water both before and abaft it, and so lay open both engine rooms on one side. It is a fortunate and wise precaution to have the erections in this vessel divided into watertight compartments by some transverse bulkheads.

There is difference of opinion as to the extent to which erections such as poops, forecastles, and deckhouses, should be taken into account in calculations of stability; but it is in most cases a dangerous assumption to make that they could be made sufficiently watertight to give buoyancy in an emergency such as we are considering. On account of their height above water, it is probable that many of the sidelights would be open (even if none of those below the upper deck were also open), and at the time of an accident, such as a collision, there are many things to be done without sending the hands along to close sidelights and doorways. It should not be forgotten that it would not require a very large aperture to admit enough water to fill the engine room in a few minutes.

Suppose, however, the vessel does come to rest wth safety, say, at 30 degrees' inclination, a reference to Fig 5 (Plate IX.) suggests certain considerations. Could stoking be carried on even in smooth water, not to speak of a sea-way? How would the vessel steam or steer with such a list? Would not the boats on the lower side be damaged, or carried away, and how could

any of those on the other side be lowered until the ship was brought upright?

I think you will agree that the question of fitting these bulkheads is a serious one, deserving of more consideration than it appears to have received. At the least, if we assume that a catastrophe could be prevented by admitting the water into the other engine room, what is the use of the bulkhead? If a steam or accident screen is desired, its lower part should be a grating to allow water to pass freely across between the rooms; and that is a very different matter. Would not a preferable arrangement for keeping some of the engine power unaffected be that shown by Fig. 12 (Plate XII.).* The side chambers might be used as store rooms below and firemen's lavatories above, and should be fitted with rapid-closing watertight doors. These chambers should preferably communicate freely through a portion of the double bottom. If the bulkheads, A and B, were placed 15 to 20 feet apart and the wall, C, at a distance 8 to 10 feet in from the side, it would be extremely unlikely that both A and B would be damaged at the same time, so that either the forward or the after engine room would be available; both screws could be used, and the vessel, although somewhat immersed by the stern, would remain upright transversely.

Warships are of course usually fitted with this longitudinal bulkhead, but their greater metacentric height, fewer sidelights, and the fact that there are often watertight bunkers at the outer sides of the engine rooms, renders their case somewhat different from that of merchant ships.

In the case of oil steamers whose compartments are longitudinally divided, it must be remembered that when these compartments are empty, the vessel, being at a comparatively light draft, has a large freeboard and probably also a large G.M. A similar argument may be applied to the case of the deep tanks fitted in full-formed steamers to secure immersion; and in both these cases the bulkheads are in valuable daily use when the spaces are filled with liquid.

Still there may be vessels of these classes in which the G.M. is

* Since writing the above I learn that the suggestion is not a new one. It is, of course, obvious that two sets of engines would be required on each shaft with this arrangement.

so small under possible bilging conditions that investigation of the stability is wise.

It is doubtless asked, what allowance was made in the calculations of the stability curves for the buoyancy due to the machinery. The dotted line at 15 per cent. in Fig. 10 (Plate XII.) shows the effect, on a single curve, of including this buoyancy. It will be noticed that at small angles the effect is a righting one, but at large angles an upsetting one; this is due to the positions of the items of the machinery, most of which are below the centre of gravity of the ship, and nearer the centre line than the bulk of the admitted water. In a similar manner the buoyancy of the unbilged ballast tank assists in heeling the vessel after a certain angle is reached. Fig. 5 (Plate IX.) shows vertical arrow lines indicating the upward force lines of the buoyancy of machinery and of ballast tank.) I made full allowance for this buoyancy in the calculation of trim, but none in the transverse curves. The ballast tank was assumed unbilged.

Reference may be made to the *Transactions* of the *American Society of Naval Architects and Marine Engineers* for 1896 and 1898, copies of which may be found in the Institution's library. These contain the results of some experiments made with models in regard to this subject.

DISCUSSION.

The CHAIRMAN (Mr. J. H. Heck) said—We have had a very interesting and also very important paper from Mr. Alexander on a question which, so far as my range of reading goes, has been very briefly dealt with in the past. I think a great number of gentlemen who are perfectly able to make such calculations as Mr. Alexander has put before us have taken it for granted that a longitudinal bulkhead, placed in a large steamer, notably in mail and large passenger steamers, was an element of safety. I think that has been very little touched upon hitherto in the question of stability, and that Mr. Alexander has done a very good thing in drawing attention to it. I should like to ask any gentleman present to speak upon this paper this evening.

Mr. ARCHIBALD HOGG said—Mr. Alexander has my thanks for this shipbuilding paper. The proper subdivision of a

passenger steamer is of the first importance so as to ensure that she will float should she meet with any mishap. It is also important that each engine should be in a separate compartment in order to ensure a means of controlling the ship should one engine room become flooded. The usual and very proper condition is that the ship should float with any two compartments full. If the engine rooms extended from side to side of the ship, the one being in front of the other, it is clear that the controlling power is lost should the vessel be hit on the bulkhead dividing the two rooms. Mr. Alexander's proposal on Fig. 12 (Plate XII.) would not prevent this, because the shock might easily be sufficient to destroy both bulkheads of the recess. Thus, in order to reserve one engine, the best solution is the centre longitudinal bulkhead.

I think Mr. Alexander has not made out a case against the longitudinal bulkhead; he does not say, for instance, what would be the effect on the transverse stability (1) if both engine rooms were flooded, the water being free from side to side of ship; (2) if the after engine room and the hold abaft it were both flooded at the same time; and (3) in a steamer with the engines placed abreast divided by a longitudinal bulkhead, if one side was flooded along with the hold immediately aft of the engine room. If the steamer has a small metacentric height when upright, the loss of inertia in the above cases may be sufficient to cause the ship to capsize, in which case there has been a serious error in the design. It is clear that, if water be admitted into one side engine room, the ship will heel over, but it is also clear that this can be greatly rectified if water be put into the tanks on the other side of the ship, the centre girders in the tank are watertight for this purpose. Mr. Alexander does not mention this or say what would be the effect on the heeling of the ship if this were done.

All these points should be known before deciding as to the benefit of fitting or not fitting the centre longitudinal bulkhead in engine rooms. It would add greatly to his paper if Mr. Alexander would give us the above information regarding the ship he investigated. Is the ship one which exists or is it an imaginary one? And did he use his approximate method in his investigation?

One should be very careful in using "approximate"

methods of calculating transverse inclination. In a vessel with broad beam and low freeboard the result of the calculation may be satisfactory, while in reality the deck may be so immersed as to take away the G.M. In this way a ship may be lost when rolling among waves and without being bilged at all. If Mr. Alexander applied his approximate method to a case where the hold is flooded at the same time as one side engine room it is possible he would find the metacentre somewhere below the gravity centre, which would be rather serious, but it is also possible that she may still float, having gained sufficient inertia as she heeled over.

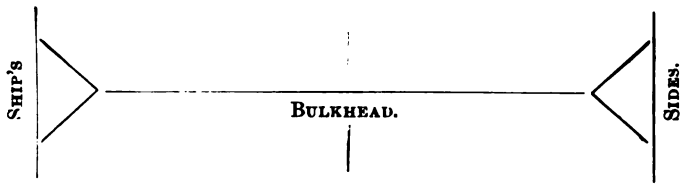
I think the longitudinal bulkhead is necessary, and the ship is supposed to and certainly should be designed with such freeboard, size of compartments, stability, etc., that she will float if bilged in any two compartments, and she should also be designed with tanks which can be filled so as to upright her. In the deep ballast tank of a broad cargo steamer it is doubtful if the longitudinal bulkhead is any good, because the loss of inertia, if the water were free from side to side of the ship, would have small effect on the stability. The bulkhead is inconvenient, it breaks stowage, the extra weight of it is so much less deadweight cargo carried. It would perhaps be a more satisfactory tank which had no longitudinal bulkhead but which had the hatch coamings 2 feet deep instead of 1 foot, as is usual; in this way the water would be always well pressed up in the tank.

The SECRETARY read the following communication:—

88, PARK ROAD, NEWCASTLE-UPON-TYNE,
4th March, 1904.

DEAR MR. DUCKITT,

Just a note to thank you for proofs of papers; that of "Longitudinal Engine Room Bulkheads," etc., is put down to be read on the 9th inst. It is a subject which interests me very much and which I agree with Mr. Alexander has not had sufficient consideration. He may not know that *Engineering* of 31st March, 1899, illustrates Messageries s.s. "Laos," which vessel has the thwartship bulkhead between the boiler rooms thus:—



In September, 1895, I took out a patent for this, but allowed it to lapse, as no one (with the above exception) cared to adopt it. In cargo tramps, or freight-earning machines, where low initial cost and small working expenses are primary elements in, or towards making the vessel a commercial success, and where any encroachment in the hold stowage or capacity is looked upon with disfavour (although the wing spaces if entered only by a manhole would probably be allowed off the tonnage), any step in this direction seems almost hopeless; but in passenger-ships, where a small additional weight, and cost in the first instance, would make the thwartship subdivision much more effective, especially as in such vessels hold stowage is not of such vital importance, and the tonnage would be decreased proportionately. It is not a little curious that our large passenger lines have, so far as I know, made no step in this direction.

Yours faithfully,

D. F. Black.

The discussion was adjourned, and the meeting dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

THE SIXTH GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON MARCH 25TH, 1904.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting, held in Newcastle-upon-Tyne, on Wednesday, March 9th, 1904, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. H. M. Wilson and Mr. Max Wurl to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBER.

Black, John, E. Draughtsman, 20, Waverley Terrace, Newcastle-upon-Tyne.

GRADUATES TO MEMBERS.

Dewar, John, Engineer, The Green, Wallsend-on-Tyne.

Jobling, Vivian, E. Draughtsman, 11, Belle Grove West, Spital Tongues, Newcastle-upon-Tyne.

GRADUATE.

Pinder, John, E. Apprentice, c/o Messrs. Adamsez, Limited, Sanitary Engineers, Scotswood-on-Tyne.

NEW HONORARY MEMBER.

The PRESIDENT said—I have the pleasure to announce that Sir Andrew Noble, Bart., has honoured our Institution by consenting to become an honorary member. Sir Andrew Noble's name is known world-wide, both as a man of science, as a great leader of industry, and as a head of the great firm of Armstrong, Whitworth & Co., and we are very pleased to add his name to our roll of eminent honorary members. The roll now includes the Earl of Glasgow, Lord Linlithgow, Lord Armstrong, Sir Andrew Noble and Sir W. H. White. I think it will be your wish that I should convey to Sir Andrew an expression of the pleasure this meeting has derived from the announcement that he has become an honorary member.

The proposal was agreed to with acclamation.

The discussion on Mr. B. C. Laws's paper on "Technical Education, in which Special Reference is made to the Admiralty System," was resumed and Mr. Laws replied.

Mr. H. M. WILSON read a paper on "Automatic Governing of Marine Engines."

RESUMED DISCUSSION ON MR. B. C. LAWS'S PAPER ON "TECHNICAL EDUCATION, IN WHICH SPECIAL REFERENCE IS MADE TO THE ADMIRALTY SYSTEM."

Mr. DAVID ANDREW said—Before Mr. Laws replies to the discussion on his very interesting and valuable paper, I wish to make some brief remarks. During the discussion I was in hopes that some member more capable would have brought forward some points in favour of a practical training in conjunction with technical education, but this may have been considered out of place in discussing a paper on technical training. However, Mr. Laws sounds the keynote when he states—"Theoretical knowledge is in no sense a substitute for practical experience, but the two judiciously combined can alone make the man able and ready to cope with the intricate problems which from time to time present themselves. Herein lies the secret of the success which has attended the system introduced into the Royal Dockyards by the Admiralty some sixty years ago by which they select their apprentices and train them for the higher duties of their profession."

After the Crimean War, engineers for the Navy were chosen to a great extent from the marine engineering establishments throughout the country. Examinations for entry were held, to my knowledge, in Glasgow and Greenock. The candidates were required to have completed their five years' apprenticeship —I may say I consider my own chance in life was gone, being at that time an apprentice—during which they had no opportunity of acquiring a technical college education in their profession, but they had at least a thorough practical training, with the result that they were in a position to carry out and perform all the practical work required on board Her Majesty's ships. But this has all been changed by the Admiralty establishing naval schools and colleges for technically educating their engineers, undoubtedly to the detriment of their practical training, for, as Mr. Laws says, the student, "when not at school, is employed on work in the yard or shops, the time

generally being divided between the several departments, enabling him to become conversant with all branches of his work." That is, it gives him a limited knowledge of how work should be done, but no training whatever regarding how to do it, which has necessitated the introduction of a new arm into the service, viz., the artificer, who performs the practical part of the work formerly done by the engineer.

The responsibility of the engineer at sea in the merchant marine has greatly increased since my time at sea, when the transition from the geared engine to direct acting, from jet condensing to surface condensing and compound engines took place, and when the triple expansion engine was talked about, but we had not reached the stage of forced draught, water tube boilers, feed filters and heaters, dynamos, refrigerating machinery, steam steering, etc. Still, in those simple times I would not care to have been troubled with a technical college educated production in the engine room unless he could handle the tools of his trade.

As the Navy has apparently no great attraction for our rising generation of engineers, or they are debarred on account of the difficulty of obtaining an appointment, or, probably, the cost of the college course, and as they cannot all expect to reach the highest position in Lloyd's Registry, or Board of Trade, or other high positions in their profession, many will probably take to the sea, for a time at least, to qualify for minor positions ashore. I would therefore impress upon them the necessity of obtaining a thorough practical training in addition to their theoretical education, in order to fit them in taking up their position in the engine room, for I am safe in predicting that it is a long way into the future before the artificer will be installed on board the merchant marine.

The Great Eastern Railway require their students to have a practical training which may be sufficient for that particular branch of engineering; but I am very doubtful if this would suffice for marine engineering, for a youth entering the works and taking two of the branches, say pattern making and erecting or turning and fitting, the five years is not too long for him to obtain a practical knowledge and become a tradesman; for as a general rule it takes him the best part of the first year to learn how to strike the chisel instead of his knuckles.

The rules of the Leven Shipyard appear to be entirely confined to a drawing office apprenticeship—in the first place the candidate must not be under 15 years of age (see Rules 7 and 8) —which is practically a theoretical training and results in overstocking an already full market, and in my opinion does not hold out any great inducement to the young man who wishes to become an engineer or shipbuilder in the true sense of the term; and I am sure it will be generally admitted that the course submitted by our Institution will be found to embody the most complete training, both technical and practical, that could be gained within a limit of five years' apprenticeship.

There is another point I would wish to draw attention to, wherein Mr. Laws says:—"The essentially practical man, who hitherto has more or less built up his fortunes unaided by scientific knowledge, has frequently derided the idea of education, and innumerable instances could be cited where it has been a positive disqualification for an applicant for a post to reveal that he held an educational diploma. In consequence progress has been retarded, and the rightful recognition of a place for engineering amongst the learned professions has been delayed." I do not altogether agree with Mr. Laws that the want of scientific knowledge has retarded progress, and I only hope that the rising generation, with all the opportunities they have for acquiring a technical education, will in the future uphold the supremacy in engineering and shipbuilding that has been established and upheld by those who have gone before them.

Mr. JAMES THOMSON said—I was not at the meeting at which this paper was read, but I have seen it in print, and have been very much interested in it indeed. There are one or two points to which I would like to refer. The author speaks in one place of advocating a general standardization of education. I am afraid I cannot agree with the desirability of standardizing education. England is a large country and the class of persons to be educated varies, so it is a good thing that in Great Britain we should have many varieties—different kinds of universities and different kinds of technical schools. I should be very sorry indeed to see any attempt to bring all our colleges to one pattern. Oxford and Cambridge cater for one class of students, the Scotch universities ca for

quite a different class, local colleges, such as ours in Newcastle, or those of Sheffield, Birmingham and Leeds, cater for much the same class of man that goes to the Scotch universities, but with some differences. I agree with what the author says here:—"As with individuals, so it is with nations. The nation which wrapped itself in the cloak of its own thoroughness, had nothing but a poor future before it. Not many years ago we held an all round pre-eminent position, to-day we have relatively retrogressed; due principally to the bias of those who have clung to old traditions and have believed in old methods while other nations have propounded new ones and stepped ahead." The Government, and some ex-Cabinet Ministers might think of this and see if want of education would perhaps explain some of the decline in British trade. I see also in Mr. Laws's paper:—"With regard to the manner in which this question has been viewed and treated in other countries it may be noted that, in most Continental states, with perhaps the exception of Germany and France, theoretical knowledge has been *too much* in evidence." I think that is quite true, and I am not sure that it does not apply to Germany as well as other countries. That is a thing one wants to guard against—the danger of having too much theoretical and too little practical knowledge. It is a danger which I think applies in America. I see the author states that—"At Cornell University there is accommodation for some 2,000 students, who enter on passing an entrance examination of no great difficulty, and continue their studies for four or five years. On leaving at about 22 or 23 years of age a student is considered to have so developed in his practical and theoretical experience as to be capable of taking the reins of management of not unimportant works." Well, no university on the face of the earth can educate a man so that at the age of 22 or 23 he is capable of taking the reins of management. It is not possible. He wants some practical experience. If we read the newspapers we are constantly reading of some great disaster in America. Sometimes a bridge breaks down and a whole train goes into a river. If bridges and other structures are designed and erected by men 22 and 23 years of age, whose only education has been in a university, that possibly explains some of these disasters. Then there is this paragraph in the paper:—"With reference to the system

in vogue in foreign countries there is one very important factor, viz., that the required training may be obtained with much lower fees and less expenditure generally to the student than in Great Britain." I do not know that fees are too high in Great Britain as a whole. If a man pays for a thing, he values it much more than if he does not pay for it. An effort has been made by Mr. Carnegie to educate men in the Scotch universities without fee, and the opinion of those best acquainted with the Scotch universities is not favourable to that. The fees are not high, and if a man cannot get money from his father or friends, or by bursaries or scholarships, really he ought not to aim at an university education. I know a good many parents send their sons to Germany to be educated, but that does not always arise from the fact that education is cheaper. It sometimes arises because they get the German language and other advantages. I did not come intending to speak, and as a matter of fact I only saw this paper in print this afternoon and read it very hurriedly; but I think it is a very interesting and valuable paper, and I wish to join in thanks to the author.

The SECRETARY read the following communication which he had received:—

ST. PETERS WORKS, NEWCASTLE,
25th March, 1904.

DEAR MR. DUCKITT,

I have read with much interest Mr. Laws's paper, and have noted with pleasure the prominent position accorded the Admiralty system of training. That the plan is a good one is abundantly proved by the results obtained and such is generally recognised by those coming in contact with the able men it has produced.

During the discussion at the last meeting mention was made by Mr. Heck of the annual competition for the Marshall cup among the apprentices of Messrs. Hawthorn, Leslie & Co. It would appear that knowledge of this competition is not general among the members of our Institution, therefore I had intended to be present at to-night's meeting and endeavour to explain what it meant. Unfortunately I cannot come, hence my writing to you.

Before dealing with the Marshall cup, it might be permissible to mention that for about 30 years past it has been the custom of Messrs. Hawthorn, Leslie & Co. to mark their appreciation of, and offer inducements to, those of their apprentices who were anxious to improve their technical knowledge. This is done by:—(*a*) Paying the fees for all evening classes in technical subjects attended by the apprentice; and (*b*) giving increased pay of 1s. per week for proficiency in workshop practice, good conduct, and time keeping.

The above rules are still in force, but in the year 1895 a very important addition was made. In that year was celebrated the engineering jubilee of the late Mr. F. C. Marshall. The apprentices on that occasion subscribed and offered to Mr. Marshall a testimonial of their regard for him, and he suggested that the best form it could take would be in the provision of a trophy to be competed for annually by all apprentices between 16 and 21 years of age in the employ of the firm. This idea was adopted, and the trophy became known as the Marshall cup. The winner has his name engraved on it, and should it be won by the same person in three consecutive years it becomes his own absolutely. This I may say has actually been done by one student, and a second cup is now being competed for. The possession of the cup for one year carries with it the privilege of entering the drawing office, and also entitles its possessor to a prize of books worth about 35s., while those taking second, third and fourth places have book prizes of corresponding value awarded them.

The interest taken in this competition may be gauged by the fact that as many as 60 young men have entered in one year for the prize. In some years the three top men on the list have been taken into the drawing office. The examinations have each year been arranged and conducted by Professor Weighton, who for a long period was intimately associated with Mr. Marshall, and to whom a great debt of gratitude is due for having voluntarily undertaken this work.

This year arrangements have been made for still further increasing the value of the competition by substituting a scholarship of the annual value of £10 in place of the book prize of 35s. This scholarship (to be known as the Marshall scholarship) is the result of proposals made by the workmen of the firm to per-

petuate the memory of the late Mr. F. C. Marshall. The principal from which it is derived has been subscribed solely by Hawthornians past and present, together with the generous assistance of the Directors of the firm. Thus in future the winner of the cup, besides being ensured entry into the drawing office, will receive a money prize of £10 which must be expended on educational purposes to the satisfaction of a representative committee; while to give encouragement to those lower down in the scale the number of book prizes will be increased.

This scholarship fund is managed by a committee of the workmen and officials of the firm.

This letter has extended to a greater length than I had anticipated, but the subject could hardly have been dealt with otherwise.

Yours faithfully,

J. M. ALLAN.

The PRESIDENT said—We are indebted to Mr. Laws for his most interesting and valuable paper. It must be a great source of satisfaction to the reader of a paper to find it the means of provoking so interesting, so useful, and so thorough a discussion. Mr. Laws must be quite satisfied on that score. The question of technical education has, we are all happy to say, taken root. We are, most of us, what are called practical men. We remember when we were apprentices we were obliged to be satisfied with a rather superficial knowledge of science, certainly of the higher branches, but less of such knowledge was thought to be necessary to carry on our work in those days. To-day the position is quite different. I think that Mr. Andrew may be quite sure of this—the British are of far too practical a turn of mind to succumb to the temptation of too much theoretical education. We are perfectly certain to stop in time. The danger, in my opinion, is that we are so proud of our so-called practical common-sense that we ignore or forget that there is another side. Germany and America have shown that there are two sides to this question. We in this country have succeeded mainly from the practical side the one Mr. Andrew and myself are most familiar with but even the practical man must see that the industrial operations of this country have now become of such complexity that the know-

ledge required to carry on the simplest of them involves the study of many fields of science. It would appear to be absolutely necessary in most industrial operations to secure the services of a sufficient number of highly skilled, highly trained, scientific men. I do not think there is the least fear that we shall go too far in this direction.

Our mechanic, our artizan, is in my opinion without any exception the best in the world, and this supremacy must be maintained.

We must not forget one thing in these discussions regarding technical education. Education may be divided into two parts. One part is required for the man as a man, apart altogether from the occupation he may bye-and-bye follow. I think it would be a great pity—a calamity almost to the country—if in our efforts to make ourselves good fitters, or good designers, we forget the other essential part—the part which will make us good men, good citizens, a happy and genial people. That educational machinery will be found in time which will combine the two I have no doubt. We must also distinguish between the training required for the mechanic and the man who is likely to occupy a position where a greater knowledge of science is required. I think it would be a great pity if we were to handicap the admirable qualities our artizans possess, and I do hope the industrious young man, the youth who keeps good time, who is plucky, energetic, and brilliant in the works, will not suffer because some puny-armed boy with a retentive memory can excel him in the evening classes. I hope any alterations made will not ignore the qualities of the practical apprentice. The Admiralty scheme appears to provide both for the practical and theoretical development of its youth and in this it is to be commended.

MR. B. C. LAWS'S REPLY.

Mr. B. C. Laws replied on the discussion. He said—The manner in which my paper has been received by the members of this Institution, and the tone of the discussion which has followed, has, I think, on the whole, shown how closely allied is the practical side of the profession of shipbuilding and engineering with the technical and theoretical side; and it has also

shown how much those who are connected with these professions realize the part that a sound, technical training must take in the development of the shipbuilding and engineering industries in the future. Apparently, however, there are those who still show a tendency to follow somewhat on the old lines, regardless of the fact that "Conservatism" and "Progress," generally speaking, are not in any sense synonymous. For proof we have only to consider how in certain industries in this country we have fallen behind relatively to other nations, who very largely have been taught by us in the past. The history of certain of the mechanical arts, to say nothing of the chemical, glass and sugar industries, for example, of this country, is, I think, sufficient evidence of this; and it is very gratifying to find now that we are making a big effort to recover a good deal of the lost ground.

I have not found it very easy to follow the sequence of Mr. Hogg's remarks, which seem to have been put together in somewhat of an involved strain. With regard to the usefulness of the drawing office staff, I quite agree with him that the men employed in the drawing offices should have every opportunity and facility for obtaining practical ideas of the work as it occurs on the ships and in the shops, and I tried as far as possible to emphasize this in my paper. If under the present conditions in vogue in the shipyards it takes, as Mr. Hogg affirms—and I do not think he will get very many to concur with him in his statement—20 years to produce the average draughtsman, then the argument I put forward in my paper for technical training seems to find some ground in that respect. That is, if it takes 20 years to train a draughtsman under the conditions existing at present it shows a great want of a proper training.

Adverting to Mr. Hogg's reference to Lloyd's Register, I think it must be admitted by every unbiassed individual that the development of the mercantile marine has gone on side by side with the name of Lloyd's Register, together with those of other Registration Societies, and it only remains for me to add that the committees of Lloyds are composed of shipowners and some of the best technical men of this country, who, in conjunction with the staff, spend a good deal of time and thought in research and experiment. The rules are an outcome of the results of this and—I think it must be admitted !

have had anything to do with the drawing office—have saved some of us many a difficult task, perhaps, in regard to the designs we have had to deal with.

Coming to Mr. Spence's remarks, they are so much in accord with the subject-matter of the paper that they leave very little for me to reply to. It is, however, very gratifying to hear Mr. Spence, who is one of the practical men in this part of the country, express such full sympathy with the subject of technical education. He, in conjunction with other speakers, both on the previous evenings and this evening, has commented on the Admiralty system of training. From personal experience of the Admiralty training, my own feeling is that it is one of the very best systems that has ever been introduced into this country, and I think the results of the schools and colleges in the Admiralty dockyards has more than justified their existence.

With regard to the practical side of the training, I would like to say that all apprentices have to work with the tools under the personal instruction of a first-class workman appointed or selected for that purpose, one instructor being appointed to each apprentice, his salary being increased accordingly. By this means an apprentice has the best possible means not only of becoming acquainted with the practical work but also of knowing how to execute it.

With regard to the introduction of technical training into private concerns, I do not think anyone would expect private individuals to introduce anything on so large a scale, but I think from the Admiralty system a good many very valuable lessons might be obtained. With reference to the relative value of laboratories and workshops in connection with the college course, I quite agree with several of the speakers that the workshop should take quite a subsidiary place relatively to the laboratory. At the same time, I think that some means should be provided in colleges by which the student may learn the manipulation of tools, so that on his resuming his work in the shipyards or the shops after the termination of the college course he may not feel himself altogether handicapped. Especially under the present system by which a student generally absents himself from the works for five or six months of the year.

With regard to Mr. Lea, who sent a contribution, I may say that he is a member of the teaching staff of one of the

principal, if not the best technical college in this country—that is, the Central Technical College in London—and I am very glad that he has found the leisure to devote a few moments to the consideration of this subject. It is quite true what he says with regard to the lack of interest very often shown by employers towards those who have studied the higher development of their profession. This apathy on the part of some of our employers has undoubtedly lost the profession, and the nation generally, many good men—many men who have been snapped up by other nations, and who have undoubtedly played a very important part in the foundation of the success of the competitors with this country. The bias shown by certain people towards education in past years, I think, has had dire effects at home. Our educational methods generally have been dwarfed, and we have lost touch with the requirements necessary for the well-being of certain of our industries.

With reference to this matter I would like, if I may do so, to quote a few remarks from a speech delivered in Sunderland a few days ago by Mr. Stuart, a Parliamentary candidate for Sunderland. In referring to the recent Education Act passed by our Parliament, he says:—"The education question was not terminated by the contours of this Act, but had a wider aspect. He pointed out that he had started the University Extension lectures, and had, when Professor of Engineering at Cambridge, established workshops in which 200 engineers were being trained. This country suffered because its rivals in trade had better systems of education, and their people were better educated. In the aniline dye trades in Germany 500 skilled chemists were employed among the six principal firms. This was 80 or 90 apiece, and he did not believe there was a manufacturer in England who employed a quarter of that number. We had not risen to a belief in this country yet of the utility of scientific training, and in the second place one could not get it if one wanted it, and as a manufacturer he had to send men to Germany in order that they might there get the instruction they could not get in this country. One good feature was that the Town Councils had now complete power over all classes of education, and power to co-ordinate those classes and carry the pupils on from one branch to the other."

What Mr. Heck has said with respect to evening study

I fully endorse. Of course it must be remembered that, however a student may spend his time, whether at college or at the shops, through the day he must of necessity work into the night if he is going to make progress, and I am not quite sure whether the complete change from manual labour through the day to study at night may not be considered a sort of congenial recreation of the mind. I think many of our best men who doubtless can look back with a good deal of pride on the education and training they have obtained at evening classes would consider the matter in precisely the same way. I think if their path had been made altogether smooth by having facilities only for day instruction they would not have made perhaps such good men as they appear to be at the present time. The evening study as obtained in our science classes under the Science and Art Department, and technical classes in connection with the City and Guilds of London, and like bodies, has had very good results in the past, but I think there has been a very great want of support to these classes. There has not been any intermediate stage by which a student could pass from the evening classes, say, on to the college. As a rule a lad who has followed evening tuition is not properly equipped for the higher courses at our technical colleges, and if he were very often he has not the means. There have been no intermediate stages by which that could be done, and I think if, for example, some minor scholarships were in vogue by which a student for two or three years could spend perhaps two or three afternoons per week at an intermediate college in order to get an efficient education by which he could pass on to scholarships of a higher value, it would be a good thing for the apprentices in some of our works and would redound to the benefit of the authors. With regard to this matter, I think such encouragements as the Marshall cup competition, which we have had put before us by Mr. Allen to-night, and which Mr. Heck mentioned in his remarks, are the right sort of thing, and I think would do more to induce a lad to develop his mind and his faculties than any inducement such as increments of salary. The one is a goal to be reached. It is something to be won and kept in view as an award of merit; the other is a thing to be obtained at one moment and forgotten the next. I think anything in the shape of a competition of this kind is a splendid inducement to lads to improve themselves.

Mr. Shaw, in his remarks, spoke of systems of training other than the Admiralty. In my paper I have mentioned that there are other systems of training besides that of the Admiralty, —such as the systems in vogue in connection with Messrs. Denny Brothers, the Great Eastern Railway Company, and the South-Western Railway Company, to say nothing of the methods introduced on the North-East Coast. All of these are mentioned in the course of my paper. With regard to the question of the administration of elementary education, I think most people will agree that the proper individuals to administer it are the political bodies, such as our local councils, as well as those who compose our national council. They are the representatives of the people, and I think one of their functions, at least, is to look after the elementary education of the people whom they represent.

Coming to the question of the professional training of engineers, I think it will be admitted that the work which has been done by the Institution of Civil Engineers has been a good work. By instituting examinations, together with the requirements of a good and sound practical training, and a thesis on the top of that, as well as recommendations from practical men, I think this has gone a long way not only to raise the status of the Institution, but also of the profession and has brought about in several instances a modification of the curriculum of some of our teaching bodies. This it must be admitted is the very essence of instituting technical training.

Mr. Macmillan refers to the London University. I am sure all those who have followed the progress of technical training in this country during the last few years will agree that the London University, as it is now constituted, has been developed on the right lines, and the fact of Degrees in Engineering—amongst other degrees of practical utility which have been introduced lately, being introduced, at once places the profession of engineering on a much higher level than it occupied formerly. And I think the introduction of these degrees, considered, of course, from an educational standpoint, should do much towards the progress of technical matters in this country.

With regard to the question of salary—I forget who the gentleman was who raised this question, but there was a question raised with regard to salary—of those who graduate

through the Admiralty training, I may say the commencing salary of Admiralty constructors after graduating successfully through the Admiralty schools, is £200, increasing annually by £15. The first two years are served on probation, except in the case of those obtaining not less than 75 per cent. of the marks at the final examination. Those individuals may obtain the increase of salary at the end of the first year. In 15 years a salary of £400 is reached as an assistant constructor, and in ten years more £600 may be reached as a constructor. Of course, there are other steps to be taken before one reaches the most remunerative post under the Admiralty, that is the Director of Naval Construction, the salary of which post may be £1,500 or more, according to the discretion of the Lords of the Admiralty. Similar increments to that which I have mentioned obtain also in the engineering staff of the Navy. In connection with the Royal Naval College, Greenwich—I may be allowed, perhaps to state this, for the benefit of apprentices who may have an idea of going in for the competition—there are a limited number of free studentships offered to those who go up first as private students of naval construction. These free studentships are obtained on the result of an entrance examination—that is, all those who wish to get a free studentship have to go up first as private students to the Royal Naval College, and before they enter have to sit out a qualifying examination. After entering they have a further examination to pass, and on the result of these two examinations the free studentships are awarded, the first man in the competition for free studentships is awarded a scholarship of £50 a year for three years. At the end of the third year—this applies both to the private student and the scholarship student—if a man gets a sufficient number of marks he is eligible for entry into the Royal Corps of Naval Constructors. The subjects of the above-mentioned examinations, together with a more detailed syllabus of the course at the Royal Naval College is given below.

With reference to the question of the standardization of education, I quite agree that it is not possible to *generally* standardize teaching; but I do think that elementary and secondary education, as well as the higher education obtained at our colleges and universities, could in the several departments be made more uniform. For example, suppose a lad has

been studying a certain department of engineering, say electrical engineering, at one of our technical colleges, and after getting through a number of terms finds himself through circumstances compelled to continue his studies at some other part of the country. He would in all probability find that he could not continue his work just where he left off, for the reason that the courses of study at the two places are not uniform, and hence valuable time and money are very often wasted.

I cannot conclude without expressing my best thanks to the Institution for the way in which my small contribution has been received, and especially to those gentlemen, including the President and those who have spoken to-night, who have taken part in the discussion.

ROYAL NAVAL COLLEGE, GREENWICH.

ENTRANCE EXAMINATION FOR PRIVATE STUDENTS.

Subjects:—

(1) Geometry. Euclid I., II., VI., XI.
(2) Algebra, up to and including the exponential theorem and logarithmic series.
(3) Plane trigonometry, including properties of triangles.
(4) Elements of statics, dynamics, and hydrostatics.
(5) Elements of co-ordinate geometry (straight line, circle parabolo and ellipse).
(6) Geometrical drawing.
(7) Practical shipbuilding or marine engineering.

This examination takes place at the Royal Naval College, Greenwich, at the end of May in each year.

EXAMINATION FOR FREE STUDENTSHIPS AND SCHOLARSHIP OFFERED TO PRIVATE STUDENTS.

Subjects:—

(1) Elements of differential and integral calculus.
(2) Elementary applied mechanics (Cotterill & Slade's Applied Mechanics).
(3) Physics and chemistry.
(4) Practical shipbuilding.

Subjects of Study at Royal Naval College (More Detailed).

Mathematics (pure and applied) including: Theory of equations, differential and integral calculus, analytical conics, analytical solid geometry, differential equations.

Dynamics of a particle, rigid dynamics, hydrostatics.

Applied Mechanics including: Graphic statics, strength of materials and structures, hydraulics.

Hydrodynamics including: Theory of stream lines, wave motion, fluid motion.

Heat, Steam and Combustion including: Thermodynamics and covers, service requirements.

Steam and Steam Engine: Deals with marine engineering principles.

Physics (including practical work) includes heat and electricity and magnetism.

Chemistry (including practical work).

Professional Subjects of: Stability and oscillation of ships, theory of waves, resistance and propulsion of ships, practical shipbuilding and laying off, ship design and calculations. Design of a ship—performed by the student—and includes all calculations, estimate of weights, horsepower, etc.

The President—I have very great pleasure in proposing that we give Mr. Laws a very hearty vote of thanks for his valuable contribution to the *Proceedings* of this Institution.

The proposal was carried by acclamation.

The President at this stage apologised for having to leave the meeting, and asked Mr. D. Andrew (Member of Council) to take the chair in his absence.

AUTOMATIC GOVERNING OF MARINE ENGINES.

By H. M. WILSON, Member.

(Read at Newcastle-upon-Tyne, on Friday, March 25th, 1904).

In introducing this paper to your notice it will be as well, as so many members of this Institution have been brought into close contact practically with the subject, to mention that it is out of the question and impossible to properly govern or stop the racing of marine engines by hand, so that the engines in a rough sea and light ship may be kept going at the normal or fine-weather revolutions and the steam-pressure and valve-openings also normal. Every engineer will tell you that when racing threatens the pressure of steam is reduced, and naturally the revolutions, to about half. Even then the engine has an occasional race. No engineer can with certainty anticipate an acceleration; he may do so for a time until at last he closes the throttle valve too soon or opens it too late. This sort of thing goes on in some cases for weeks, occasionally ending without any apparent damage or mishap, and at other times a part of the machinery gives way, which, if the shaft, is frequently set down to corrosion or bad material, especially at the tail end, and on examination these causes are evident. It is true that galvanic action is blameable for a great deal of it, but the severe twisting strain, which is worse close up to the propeller, caused by the acceleration when the propeller is out of the water or less deep than the normal, causes us to look further for an important and very active assistant in this work of destruction. If there was no racing of the engines at sea, galvanic action would be much reduced, as no doubt the wrenching or torsional strain put upon the shaft close to the propeller, where the taper begins, is so severe that the outer skin or surface of the shaft is slightly abrazed in time and the new and clean steel or iron is attacked

greedily by the electric fluid, infinitesimal as it is. There have been many devices to prevent this wasting or corrosion (as we call it) by covering this part and allowing of the tail shaft to be examined by cutting away the stern tube at places between its bearings, but with small success.

Though there is a similar twisting strain at each end of the shafting, *i.e.*, the crank shaft and the propeller shaft, yet at the engine end, owing to the cushioning, and especially if the valves have good and generous leads, the strain due to the momentum of the piston and rods should not be anything like as much as the propeller end. Fig. 1 (Plate XIII.) will help to illustrate my meaning. This shows an engine and line of shafting. Say the line of shafting is 100 feet long and $12\frac{3}{4}$ inches in diameter, suitable for an engine 24, $39\frac{1}{2}$, and 65 inches by 48 inches and 180 pounds W.P. If there was no racing or galvanic action to take place this shaft would not be more than $11\frac{3}{8}$ inches in diameter, but owing to breakdowns in this particular department the various registries have within the last ten years increased the dimensions of shafts as will be seen by comparing the sizes given in the following table:—

COMPARATIVE DIAMETERS OF SHAFTING FOR AN ENGINE OF THE SAME POWER IN 1890 AND 1900.

Authority.	Crank Shaft.		Thrust Shaft.		Tunnel Shaft.		Propeller Shaft.	
	1890.	1900.	1890.	1900.	1890.	1900.	1890.	1900.
	Mean diam.	Mean diam.	Mean diam.	Mean diam.	Mean diam.	Mean diam.	Mean diam.	Mean diam.
Lloyds	$11\frac{3}{4}$	$12\frac{3}{8}$	$11\frac{3}{4}$	$12\frac{3}{8}$	$11\frac{1}{4}$	$11\frac{3}{4}$	$11\frac{3}{4}$	$13\frac{1}{4}$*
Board of Trade	$11\frac{7}{8}$	$11\frac{7}{8}$	$11\frac{7}{8}$	$11\frac{7}{8}$	$11\frac{1}{4}$	$11\frac{1}{4}$	$11\frac{1}{8}$	$12\frac{1}{2}$
British Corporation ...	$11\frac{3}{4}$	$12\frac{1}{8}$	$11\frac{3}{4}$	$12\frac{1}{8}$	$11\frac{1}{4}$	12	$12\frac{3}{8}$	$13\frac{1}{4}$†
Bureau Veritas	$12\frac{1}{8}$	$12\frac{1}{2}$	$12\frac{1}{8}$	$12\frac{1}{2}$	12	$11\frac{3}{4}$	$12\frac{1}{8}$	$14\frac{1}{8}$

* If with continuous lines in one piece. † For hull coefficient of ·6.

The sizes are worked out for a 3-crank vertical triple expansion engine having cylinders 23, 38, and 63 in. in diameter, with a stroke of 45 in.; working pressure, 180 lbs. per square inch.

The latter shafting, with 70 revolutions ordinary running, shows a torsional deflection of ·40 degrees and a race of 50 per cent. increase; or 105 revolutions shows a further deflection of ·24, making a total of ·64 when the propeller strikes the

water at this increase of speed, in the 100 feet length. Of course this deflection or amount of angular difference which the shaft is out at each end is carried through the whole length at the same time; when the propeller first strikes the water at this increased momentum the shock is felt there first and consequently gets the first blow, which is a very severe one. The greatest shear stress in the shaft at 70 revolutions is about 5,000 pounds per square inch, and when the propeller, racing at 105 revolutions, strikes the water the greatest stress is about 8,500 pounds per square inch. These calculations are a "near approximation;" for to obtain a correct solution scientifically it would be necessary to have the weights of all the moving parts, so that the inertia forces might be correctly found, as well as the exact time that elapses between the moment of maximum race and the time when the engines again assume their normal revolutions. The figures of course have been obtained mathematically and several quantities have had to be carefully estimated. Mr. Jasper Cooper of London last year made a series of calculations to ascertain the stresses on the frame of a torpedo boat destroyer's engines, showing the stresses set up by the inertia of the moving parts, in a destroyer of about 4,000 I.H.P., with a connecting rod of a ratio of 2·16 to 1 of the stroke. The tensile and compressive strains set up on a single back column, on a single front column, and on a single cross stay from the front side of bedplate to the centre on side of guide, and all these between the H.P. and M.P. cylinders, showed as follows:—Back column 1,586 and 1,730, front column 7,705 and 5,052. Cross stays tensile only 8,020 when running at 400 revolutions per minute.

The size of this engine is 19½, 30, 34, and 34 inches by 18 inches.

Receiver Pressure H.P. ...	220	pounds	per	square	inch.
,, ,, M.P. ...	90	,,	,,	,,	,,
,, ,, each L.P. ...	20	,,	,,	,,	,,

It would not be difficult to imagine or realise to what this would amount when the revolutions are suddenly increased and as suddenly removed again. All, I think, will admit it would be a very active load if suddenly increased 50 per cent., *i.e.*, from 400 to 600 revolutions; and if calculated with the

ordinary safety factor for the normal speed of 400 revolutions the whole would collapse under the extra heavy strain when racing.

With these facts before us it is evident that the marine reciprocating engine which is subject to variable loads requires a good and efficient automatic governor more than a land engine; and yet a land engine is seldom seen without one. How is this? The reason is not far to seek. Superintendent engineers will tell you they have not seen a thoroughly reliable governor that is anticipatory enough, and that they are so complicated and delicate that when anything goes wrong with them, they have not the time and cannot trouble to put them right, and this perhaps happens at the time when they are most needed.

By looking at Lloyds' Report of casualties to steamships for the last six months it will be found that from 25 to 30 per cent. of breakdowns are due to shafting or propellers giving way, not counting accidents to the engines. It does not explain how these occur, but no doubt the bulk of them are caused through the severe strain from racing, perhaps not directly in every case, but resulting from it. It would be waste of time to point out to a shipowner or superintendent engineer at this meeting the reasons why a good and efficient governor should be used on their engines. An efficient and reliable governor is one that may be depended upon to act with no greater increase in the number of revolutions than 5 per cent. and one that, in case of a breakdown between the engine and propeller, causing a serious increase in the number of revolutions dangerous to the ship and which has been known to result in foundering, shall close down the throttle valve effectually against any effective admission of steam until released by hand. If this is effectually carried out, it would not be long before the Board of Trade, Lloyds and the other registrations to shipping would relax their rules at present applied to shafting and which owing to their high co-efficients are becoming ponderous and unworkable.

Some engineers say they prefer hand throttling in rough weather, as no governor could anticipate a race. An engineer cannot do so. Many sea-going engineers will tell you of the horrors of racing when going light over the western ocean, how on each watch for days he has to stand at the throttle handle, not daring to leave the place to attend to the numerous other

necessary duties, and has to rely upon a donkey-man or other assistant, this man perhaps working with a choked pump, one out of many of the numerous auxiliaries that make up the list of the present-day engine room on board ship, which compared with twenty years ago is as about 3 to 1.

Superintendents, reasoning in this fashion, naturally leave such a thing as a governor out of their specifications, and also leave the ship and engines to chance.

The question now arises, Is it more economical to reduce your steam and revolutions, go at half-speed and throttle by hand or go at normal fine-weather speed in a heavy sea with a reliable governor? It is unnecessary to answer this question, as there are no two opinions about it, that the latter is the more economical, provided you have the safe and reliable governor.

We have, as constant factors, the same inertia, cylinder, and boiler to contend with, combined with the linking-up, causing wire drawing, which has been estimated to reduce the steam pressures as much as 20 per cent. in entering the cylinder, as compared with the pressure in the valve casing, and when linking-up takes place.

If it was possible to have everything reduced in proper proportion, *i.e.*, engines and machinery generally, then $\frac{1}{4}$th of the power would be necessary.

Again, the ratio of expansion, being naturally affected as regards the total and the notching-up to keep the feed water constant or as nearly so as possible, necessitates closing down the Kingston within certain limits, as with the increased expansion and less pressure there is very little steam to condense.

These faults added together, in a case of heavy weather, throttling by hand or having to move along under breakdown conditions through racing or other cause, is a serious item against the shipowner, not only in the coal or fuel bill but in loss of time and wages.

The strain thrown upon the parts of an engine when racing is very great. The ports and passages as well as the valve openings being designed for, say, a speed of 550 feet per minute, there will not be sufficient lead and cushioning to check an engine increasing its speed suddenly to double or even less. However tight the throttle is shut down, and the engine gets away, the vibration will be increased owing to no steam being

in the cylinders to speak of, or what got there would be all swept out in one revolution, after the valve was closed. The pumps draw less water and the plungers or valves and rams come down on the water and seats like hammers on a solid body and with increased force—the same as the propeller—and put extra stress on the gear and parts dependent, knocking them to pieces in no time. When running at their normal speed this is not the case. If the throttle is shut soon enough all vibration is done away with, and also the excessive twisting strains in the shaft.

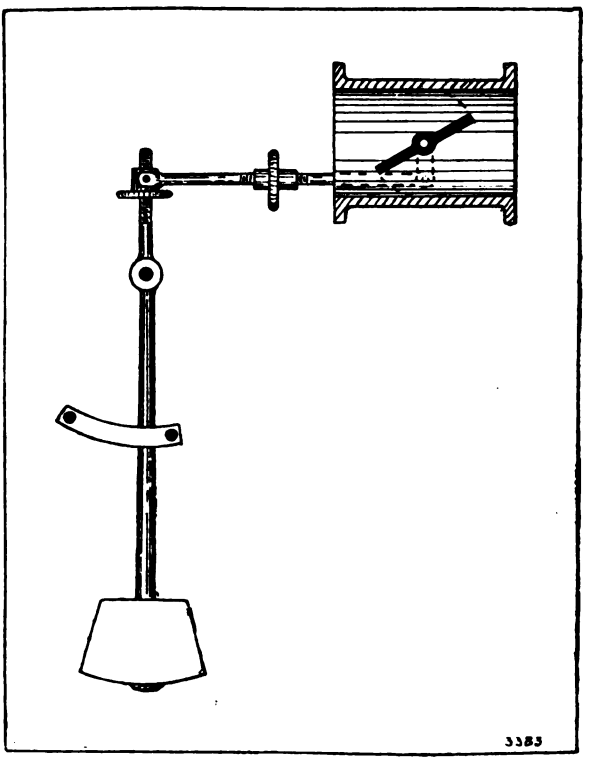
There are still a great number of steamship engines fitted with the old style of governors, which are of little or no use at all.

A description of the principal governors, as well as of more recent ones for comparison, will perhaps be interesting here. By going back to 1811 we find the s.s. "Comet" fitted with an ordinary centrifugal ball governor, and in 1856 W. E. Newton patented an improvement on these governors. In 1857 Taylor brought out a governor on an entirely new principle. A cylinder was placed in near proximity to the propeller and connected at the bottom to the sea; a float in this cylinder was connected with the throttle valve by means of a rope or chain with a balance weight hanging at the further end. When the propeller was deeply immersed the sea would fill the cylinder and keep the float at the top and the throttle valve open, but as soon as the head of water decreased the float would fall until, the propeller being out of the water, the throttle would be closed. This governor did not answer in practice.

The same year Thomas Silver invented a governor which at the time was thought much of. This governor is the first of my illustrations (see Fig. 2, Plate XIV.) and perhaps a few will recognise an old friend. A is a large flywheel having vanes for the absorption of a certain amount of energy, and free to revolve on the shaft, S. The bevel wheel, B, is keyed to the shaft and the toothed quadrants, C1, C2, gear with it and are free to turn round pins on the extended pass of the flywheel. A rope is passed from the propeller shaft round the pulley, D, causing the bevel wheel, quadrants and flywheel to revolve. When the engine is inclined to race, the flywheel, owing to the vanes, is checked somewhat until an extra force is added to overcome the inertia; this force causes the quadrants to revolve to a certain extent

round their point of suspension, which compresses the spring, E, and closes the throttle valve, through the lever, H. Though this governor gave satisfaction at the time, it failed through being so unwieldly, as the force to close and open the throttle was dependent upon the inertia of the flywheel.

Several governors were invented about this time. Pinkney's (see sketch) depended upon the movement of the ship and seems closely allied from its appearance to one bearing a nearly similar



PINKNEY'S GOVERNOR.

name. It is a pendulum governor pure and simple. Meriton's acted like Silver's, but differed in its connection with the throttle. A. V. Newton patented a governor which depended upon the difference in speed between the main engine and a small engine running at a constant speed.

No great advance was made until 1871, when Dunlop patented his governor. This governor is shown in its improved form (see

Fig. 3, Plate XV.). A sea cock at the stern of the ship opens into an air vessel, so that by opening the sea cock water flows into the air vessel and compresses the air contained therein to a pressure equivalent to the head of water outside the ship. A pipe communicates with the air chamber and the under side of an air-tight elastic diaphragm in the engine room. A spring is fitted on the top of the diaphragm for adjusting the compression to balance the air pressure on the under side of the diaphragm. A connection is made from the diaphragm to the slide valve of a small steam cylinder, so arranged that this cylinder piston, which is connected with the steam valve of the engine it has to control or govern, moves in exact uniformity with the movements of the diaphragm. The variations of the head of water outside the ship when the sea cock is opened causes an inflow or outflow of water and consequently a variation in the pressure of the air in the air vessel and on the under side of the diaphragm, which causes the diaphragm to move and compress the spring to the requisite balance of spring and air, thus causing a corresponding movement of the governor steam piston and necessarily the valve of the engine under control. The distance of the sea cock from the diaphragm makes scarcely any diminution in the pressure and time of actuating the governor, and the spring in the diaphragm can be so adjusted that the diaphragm and steam valve commence to act with a small acceleration in the speed of the engines under control. This governor was put forward as anticipating any acceleration due to the propeller being out of the water.

Lake's governor, invented in 1874, acted upon the principle of churning water in a drum to obtain a certain speed and had mechanism for acting upon the throttle valve when the engines tended to race.

Churchill's governor, patented in 1879, was no doubt the best at the time and it is still to be found afloat on some of the older boats. Fig. 4 (Plate XVI.) is a section from which it will be seen there is a fan within a cylinder filled with water as a retarder at one end of the spindle; at the other end are the driving pulleys. On the fan spindle is a small cup which has two pieces cut out of its side so as to form a double cam. This cup works inside a larger cup carried by the driving spindle, having two slots cut in it opposite one another. There is

no direct connection between the fan spindle and the driving spindle. There is an intermediate or cross-shaped spindle; on the two arms at right angles to the axis are four friction rollers. The inner rollers, being conical, bear on the cams, in the small cup of the fan spindle end; the other rollers work in the slots of the large cup attached to the drum spindle end. There is a slot cut through the driving spindle immediately under a hollow in the inner end of the same shaft, and in this hollow the long arm of the cross spindle, which is the action of the motion, is inserted. Below these is a collar and space for movement in the axis of motion of the shaft. This collar is connected to the spindle by a pin passing through the slot. A bell-crank lever passes at each side of this collar, which actuates it and the lever. One end of this lever is held down by a spring and the other or short end is pivoted on a double jaw and is connected with the slide rod of a steam cylinder, which cylinder swings in a pivot in an arc of 180°; thus making it possible to have a direct lead or nearly so. This governor has the advantage of being either driven ahead or astern with an open rope.

Its action is as follows: The power to drive the fan is transmitted from the large cup to the smaller one through the rollers mounting the cams, which thus forces the long arm of the cross spindle into the hole in the end of the driving shaft and carries with it the pin passing through the collar and slotted hole giving motion to the collar and carrying with it the bell-crank lever against the tension of the spring which operates the small steam cylinder and thus the throttle valve. Engineers argued that checking the admission of steam to the high-pressure cylinder in governing was not enough to properly control compound or triple engines, and that steam in the casing and the vacuum acting on L.P. piston would be sufficient to cause dangerous racing. To meet this, Durham and Churchill introduced a "compound attachment" with the governor just mentioned. It was invented by Jenkins and Lee and consisted of an intermediate valve fitted into a pipe having a connection to each end of the L.P. cylinder. This pipe had a stop valve at top and bottom, and the intermediate valve was worked by the governor, so that when the engine was throttled this valve was opened at the same time, and threw one L.P. piston into equilibrium.

Cout's and Adamson's governor, invented in 1880, is in its action something the same as Dunlop's but differs from it by the diaphragm actuating the slide valve of a small steam cylinder in a different manner. Fig. 5 (Plate XVII.) shows a part section of the governor; the connections are the same from the sea at the stern of the vessel to the diaphragm, which has the same parts, with a difference in the connections from the diaphragm and the steam cylinder for actuating the throttle valve.. The cylinder, O, has a connection with the condenser at the bottom and there is also a connection (through the valve attached at the end of the spindle from diaphragm) to the steam. The upper side of the piston is open to the atmosphere at P, and the connection to the throttle valve is from R. The throttle is closed when the piston is at the top. The springs combined with the atmosphere forces the piston down again.

Thunderbolt's governor (see Fig. 6, Plate XVIII.) consists of double-acting air compressors, a patent automatic adjustable regulator, and a cylinder containing a piston for controlling the throttle valve. These parts are attached to any convenient place in the engine room and are connected by a half-inch copper pipe, through which the air is conveyed. The regulator has an equilibrium outlet valve, E, which is operated by the pendulum, E1, suspended from the adjustable sliding fulcrum, E2. If the stern of the vessel rises out of the water, the pendulum, E1, will assume such a position as will close the outlet valve, E, and prevent the escape of air. Underneath the throttling cylinder, D, is fixed a quick-acting valve, C, containing a small spring piston, C1. This piston is adjusted to resist a greater pressure to the square inch than the spring throttling piston in the cylinder, D; consequently, when the air forces back the piston, C1, it is admitted into the cylinder, D, at a pressure more than sufficient to force up the piston rod, D1. When the air pressure becomes normal the piston, C1, returns to its original position, and allows a free escape of the air from the cylinder, D.

When the governor acts, the air compressors, A, driven from the main shaft by a belt or other means to the patent clutch pulley, B, force air at a predetermined pressure through the pipes, B1, B2, with an outlet at E. Any tendency of the engines to exceed the adjusted maximum speed would cause the air compressors to discharge more air than could escape through

the adjusted outlet valve, E, thus increasing the air pressure against the piston, C1, which would be forced back, and the air admitted to the throttling cylinder, D.

As the stern of the vessel rises, the pendulum, E1, operates and closes the outlet valve, E, and the increased pressure forces back the piston, C1, which allows the air to enter the cylinder, D, and force up the piston rod, D1, so as to close the throttling valve. With the return motion of the vessel the pendulum will

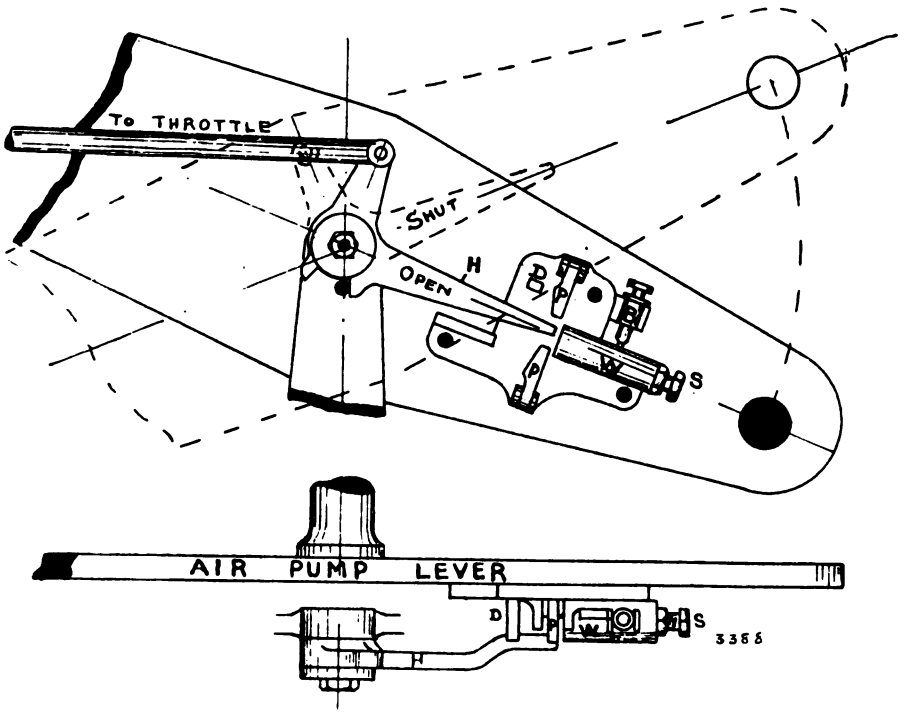


FIG. 7.—ASPINALL'S GOVERNOR.

act to reopen the outlet valve, E1, until the air pressure becomes normal. As the piston, C1, returns to its forward position it opens the escape port for the air from the cylinder, D, and as the piston rod, D1, returns it opens the throttle valve. D2 is a safety valve. It will thus be seen that the action of the pendulum, E1, causes the synchronous movement of the piston rod, D1, and with it the throttle valve of the engine.

Aspinall's governor (Figs. 7 and 8) is the latest and is purely an inertia governor, and is entirely new in its method of

applying that principle to governing. One great point in its favour is that it is always ready to close the throttle immediately a pre-determined increase of speed takes place, no matter from what cause, without using up energy as is the case with rope or power-driven governors. The only time work or energy is absorbed is when the throttle valve is either being closed or opened. It can be adjusted so that an increase of a revolution or two per minute will cause the throttle to close, and if required it can be given a wider range. They can be adjusted so that they will open at

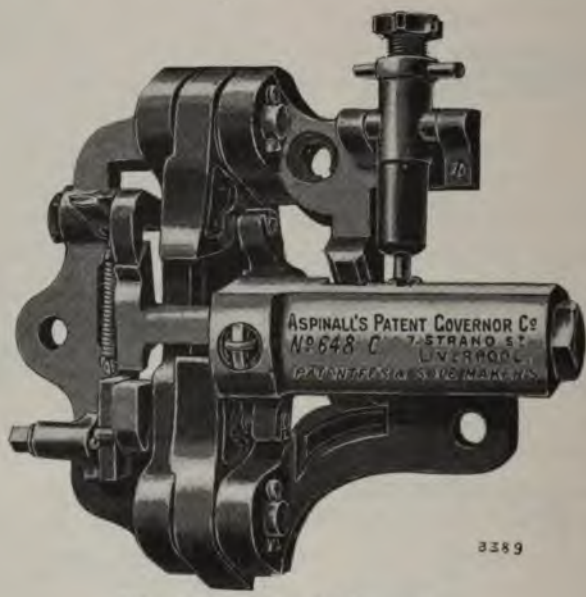


FIG. 8.—ASPINALL'S GOVERNOR.

one revolution to ten revolutions' increase in the engine under control, and in either case the throttle is opened again directly the engines return to their normal revolutions. In the case of a shaft breaking or any other mishap which would cause serious acceleration an emergency gear comes into action and closes the throttle close down, and this emergency has to be taken out by hand before the throttle valve can be reopened.

Referring to Figs. 7 and 8 it will be seen that this governor is very compact and simple. It is bolted to the air-pump lever or, if desired, to a special rocking lever, from which it is a

simple matter to take a connection to the throttle valve, as it may be placed with its lever on the forward column directly under the throttle valve.

It consists of a weight, W, mounted on a spindle parallel with, but a short distance from, its axis towards the lever. When the inertia of this mass, due to the reciprocating motion of the lever, is sufficient to overcome its weight it will swing about its spindle at each stroke of the engine. But in so doing it causes either the top or bottom pawl, marked P, to swing outward, so that it engages with the lever, H, and closes or opens the throttle valve. Now, when the weight takes up its upper position, the lower pawl swings outward and closes the throttle by pushing the lever upward, as shown dotted, and a small catch or detent holds the weight in this position until it is released by the detent striking the lever, H, as the governor swings downward on its return stroke. If the engines have then resumed their usual or normal speed the weight will swing into its bottom position, and the top pawl will open the throttle on its next downward stroke; but if the speed is still above the limit the weight will remain in its top position, keeping the bottom pawl out and the throttle closed. The emergency gear comes into action in the case of a tendency for excessive racing, such as losing a propeller or breaking a shaft. A smaller weight is then thrown upward or left behind and locks the larger weight previously thrown into its top position and keeps the throttle shut until, as previously explained, it is released by hand. The governor is adjusted by means of the screw, S, and the spring, B.

At first sight this governor's action seems rather complicated, but it is simplicity itself when once understood. A good illustration of its action is to place a coin or weight in the palm of the hand and swing it up and down commencing slowly and increasing the speed gradually until the speed is sufficient to cause the inertia of the coin or weight to be overcome, when it is left behind and the hand descends without it.

There is nothing to get out of order, beyond what occurs by fair wear, and any part of it can be put right, should the time of excessive wear of years arrive, in a very short time and at a very small expense. Any very ordinary engineer or mechanic can master its working and parts in a few minutes.

No governor can be made more anticipatory, as it can tell an increase of one revolution and two at most, and they are guaranteed in an engine of 60 revolutions not to exceed three revolutions, and they have been adjusted as low as 1·66 per cent. in 60 revolutions time. At the commencement of last year there was a paper read at an institution in London, where the lecturer said "the Aspinall governor was a governor on the 'hit-and-miss' principle, as in gas engines. The Aspinall governor would only cut off the steam of supply once during a revolution, and owing to its rigid gear it could not allow the throttle valve to close entirely." The lecturer, unknown to himself, paid the Aspinall governor a high compliment when making it cut off as low as one revolution; but comparing it with gas engines, they are two cycle as a rule and might, as is often the case, not act until the speed limit just occurs when the normal revolutions are reached at the end of a non-supply, which means they drop considerably (if a heavy load is on) before the next two for supply arrives.

The rigidity he mentions is preferable, as by this means the governor is made as sensitive as it can be, and is generally adopted, for they are made either rigid or not. No governor should be so made that the valve comes hard on the face of the throttle when closing, as it not only sometimes jams, especially with the pressure of 200 pounds per square inch upon it, but puts a severe strain on the valve spindle, which in time will result in fracture and cause serious delay and probable danger before it can be repaired and the valve opened again. With an all-round butterfly valve which can pass or sweep the closing point, there is no risk of the kind described.

I trust this paper will prove of interest and provoke a discussion.

In conclusion I beg to tender my thanks to the Feilden Publishing Company to whom I am indebted for the use of the blocks illustrating this paper.

DISCUSSION.

The CHAIRMAN (Mr. D. Andrew) said—We have to thank Mr. Wilson for bringing a paper before us which is purely an engineering question, and one which appeals to engineers, and more

particularly to those who have experience of sea-going life, and the troubles attached to the engines in bad weather. I am sorry I do not see many of our superintending engineering friends here to-night, who I am sure would give us their experience in regard to the governing of engines at sea, but I have no doubt there are some gentlemen present who will be prepared to open the discussion on this very interesting point.

Mr. WILLIAM WELBURY, Leeds (by permission of the Chairman), said—I came in here to-night hearing that my friend Mr. Wilson was reading a paper. I happened to be in the North of England, and I find I have got a crow to pick with him to start with. I happen to be the man who read the paper in London which he calls into question. He has made a slight mistake—of course, we are all liable to make mistakes. He reports that I said "the Aspinall governor was a governor on the 'hit-or-miss' principle, used for gas engines. The Aspinall governor would only cut off the steam of supply once during a revolution, and owing to its rigid gear it could not allow the throttle valve to close entirely." What I actually said appears in vol. xiv., 107th paper, on page 41 in the *Transactions* of the Institute of Marine Engineers. During the discussion on this paper I was asked a question with regard to the principle on which the Aspinall governor worked. I said I had heard a good deal about it, and it did not strike me that there was any other well-known governor that I could compare it with but the "hit-or-miss" governor. It was a governor on the same principle as this, which, of course, is the inertia principle. It would only cut off the steam once during a revolution, only open the steam once during a revolution, and owing to its having rigid gear, they dare not allow the throttle valve to be closed entirely. It had to be left so far open in case an accident to the gear might occur through vibration.

I happen to have had rather a unique experience in engineering. I spent 17 years of my life at sea, and I have been since for 15 years employed in a responsible position with a firm of stationary engine makers who are very well known; therefore I may claim to know something about this subject.

Mr. Wilson mentions stationary engines in his paper. They are very seldom seen without a governor. We could not sell them if we did not fit them with goverr

goes to sea, out of sight, and nobody very much cares about it so long as the ship makes her passages. The reason why stationary engines are more easy to control than marine engines is because they have a flywheel. You could not possibly put a flywheel heavy enough to be of any service on a marine engine. Stationary engine governors are of various sorts and descriptions. They are both centrifugal and inertia, and combinations of both principles. The old Watt governor you will still find in use. I do not think it is put on new engines now, but you will still find it on plenty of old engines running in this country and doing good work. The centrifugal and inertia combinations you will often find on engines working with trick gear. The Porter governor is a well-known example, it has fly balls, which raise a central inertia weight. There is another made by Isaac Storey & Sons, of Manchester, much used with trick gear. There are shaft governors in use, which are very sensitive and stable if properly designed, but moving a heavy valve with a pressure of steam at its back means that the governor has to perform a great amount of work, and they have to be made very powerful, or they would lose their stability, and hunt; undue friction in a governor will also cause hunting. I only know one example in which the centrifugal and inertia principles are combined in a shaft governor. Shaft governors on the inertia principle have not been found successful for stationary engine work. There is too much friction on them; therefore the centrifugal governor is mostly used where that class of governor is preferred. It forms a simple arrangement, the governor being direct coupled to the distribution valve, which is mostly of the flat or piston type of slide valve. My firm a short time ago made an engine of 3,000 I.H.P., an enclosed engine running 200 revolutions per minute. It is now in the Leeds Electric Lighting works, and I think may be claimed as the most powerful enclosed engine in the world. It is governed by a shaft governor, designed on the centrifugal and inertia principle, working direct on the H.P. distributing valve which is a flat balanced slide valve.

I was sorry not to hear Mr. Wilson make some reference to the different qualities with which it is necessary to endow a governor. I also quarrel with his definition of an efficient and reliable governor. It is not what one would consider sufficien

for a governor merely to be able to act. It is no use a governor acting if there is no result therefrom. As it acts the result should instantly be felt by the engine, and a really efficient and reliable governor should be one that is stable, that is to say, has sufficient power for its work, and is very sensitive. He has said nothing, either, about the effects of friction in a governor. They are sometimes very serious. With regard to the range, fine or rough, it is quite possible, though not often done, to make a governor practically isochronous and thus control the speed of an engine within ½ per cent. or less, but you must not have a very varying load on that engine. It must have a steady load, or you will be troubled with hunting. It is not impossible, and it has been done, but is not the usual practice. Governors are now generally made for electric lighting engines to keep the speed within 4 to 5 per cent. As a matter of fact I have, in my pocket book, some tests I took a few days ago—rough tests. Here is one: The speed at no load was 333 revolutions, at full load, 322 revolutions. That is very fine—11 revolutions in that speed. I have another test here taken on the 9th March: The no-load speed was 324; half load, 317; half load pulled off at the main switch, the speed went up to 325, and settled down at 323. The momentary variation there is very slight. The same engine further tested gave the following results:—No load, 323 revolutions; full load, 313; load pulled off, 328, and settled at 323. Running at 322 revolutions, three-quarter load was thrown on and the revolutions dropped to 317. That is very fine governing, showing about 3 per cent. variation and is as fine as you can go with safety.

With regard to what Mr. Wilson said about the Aspinall governor, I am sorry to find he gives us no figures. He talks about the speed going up 50 per cent. It often goes up much more, or it did when I was going to sea. He charges superintending engineers with not taking sufficient interest in the governing of marine engines. He is perfectly correct in that, but I must charge all of you marine engineers with not taking sufficient interest. I have given you some figures to-night which are exact—accurate. Why cannot you have similarly accurate figures? Why do you not know what speed your engine goes to when your propellor comes out of the water?

It will only cost you some £10 for a tachometer, and you can read your speed on the dial at any time.

My experience of marine governors commenced in 1871. I was trading, or rather making a few voyages across the Atlantic in a ship which would not be called a big ship now, 750 tons register. We had a Meriton governor, and it used to act fairly well. It closed the throttle valve, but unfortunately it opened it again immediately afterwards. The governor had no stability; it hunted. I had similar experience with a Silver governor about 1888, and I managed to get that governor to act very well on a compound-engine, but still it was not all that could be desired, and I do not believe myself that you ever will govern a marine engine without you use some other means than throttling. You must have something to replace the flywheel, or compensate for its absence. The inertia of the flywheel is the main point in the governing of the stationary engine. Where we have fitted stationary engines with light flywheels, we have a great momentary variation in the speed. I have some Moscrop diagrams from the Moscrop recorder which show at a glance the difference in an engine running with a light flywheel and with the weight of flywheel doubled.

It consists of a clock, steam gauge, and pendulum governor working in conjunction. A roll of paper is so connected to the clock that its mechanism unwinds it, a hanging weight connected to a drum rolling it up as it is unwound by the clock. The steam gauge is coupled up to a pen which draws a line on the paper as it passes on the drum, indicating the variations in pressure of steam at the boiler. The pendulum governor also has a pen connected to its mechanism, which marks on the paper the slightest variation in speed indicated by the rise and fall of its weights; as the governor has no other work to do—being practically frictionless—but move this pen, it is very sensitive.

The marks you notice across the edges of the diagrams represent time, this being divided into periods of five minutes each by the lines. The other lines lengthwise of the paper are to measure the speed variation, and are set off in percentages, showing a difference of 5 per cent. between the lines.

The Moscrop diagrams (Plate XIX.) are taken from a stationary engine driving an engineering works.

Fig. A was taken when the governor was out of action during the time some trifling repairs were being made to it. It shows the variations in speed which took place with the engine running on the throttle valve without governor, and with what may be considered a fairly steady load.

Fig. B was taken some years ago, and shows a speed variation of about 5 per cent., and was considered a good diagram, this regulation for the class of engine being held to be highly satisfactory.

Fig. C was taken after a heavier flywheel had been fitted. A comparison of the two diagrams shows at a glance the effect of fly-wheel inertia on speed regulation.

From these diagrams we see the effect of light flywheel with a good governor; heavy flywheel and good governor; and flywheel without governor.

With regard to governors in which the motion of the ship is taken to control the engines I consider that is a most unreliable way to try and govern an engine. It might be all right if your seas were true always the same height and length. Then you might do it, but I think that the motion of the sea is entirely too unreliable a source from which to obtain your speed regulation.

Then again, Mr. Wilson mentioned anticipatory governors. I have always thought it impossible for a governor to anticipate a change of load on an engine. The load cannot anticipate its changes. How, then can a governor? You cannot put brains into a governor. Even a man at the throttle valve cannot always reliably throttle the engine. He cannot hit it every time. Further, I think myself that the fact that an anticipatory governor is asked for, for a marine engine, conclusively proves that throttling is not sufficient in itself to control the speed of the marine engine.

The CHAIRMAN said—The discussion will be adjourned until our next meeting. I think we should endeavour to get some of our sea-going engineer friends to discuss this paper. It is a paper that these men, directly connected with engines at sea, who can realize the difficulties that are to be contended with in governing engines, should be particularly interested in, and it would be a great advantage to have their experience.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

SEVENTH GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE ROOM OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY, APRIL 22ND, 1904.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting, held in Newcastle-upon-Tyne on Friday, March 25th, which were confirmed by the members present, and signed by the President.

The PRESIDENT appointed Mr. David Andrew and Mr. J. H. Heck to examine the voting papers for new members, and the following gentlemen were declared elected:—

GRADUATE TO MEMBER.

Glahome, John William, Engineer Draughtsman, 43, North Terrace, Wallsend-on-Tyne.

GRADUATES.

Hogarth, Horace, Electrical Engineer Improver, 196 Wingrove Avenue, Newcastle-upon-Tyne.

Moore, Edward George, Engineer Draughtsman, 32, De Grey Street, Elswick, Newcastle-upon-Tyne.

NOMINATION OF OFFICERS.

The PRESIDENT said—I have to announce, in accordance with Article X. of the Constitution, that the following gentlemen will retire from the Council:—

President—Mr. John Tweedy (not eligible for re-election).
Vice-Presidents—Messrs. G. B. Hunter, D. B. Morison and T. Westgarth (eligible for re-election).
Hon. Treasurer—Mr. G. E. Macarthy (eligible for re-election).
Ordinary Members of Council—Messrs. E. W. De Rusett, J. H. Heck, R. Wallis and G. D. Weir (not eligible for re-election as Councilmen).

The PRESIDENT said—In accordance with Bye-law 11, I have now the pleasure to nominate, on behalf of the Council, the following gentlemen to be balloted for to fill the vacancies already referred to:—As President I beg to nominate the Right Hon. Lord Armstrong. Lord Armstrong is a busy man, and I think it is a compliment to the Institution that his Lordship should have signified his pleasure to place his services at the disposal of the Institution.

Vice-Presidents—Messrs. J. H. Heck, G. B. Hunter, D. B. Morison and T. Westgarth (three to be elected).
Hon. Treasurer—Mr. G. E. Macarthy.
Ordinary Members of Council—Messrs. M. C. James, Hugh Laing, Hon. C. A. Parsons, R. Ropner, jun., W. Swinney and R. Saxton White (five to be elected).

If there are no additions I shall suggest that these nominations be confirmed.

There being no additions, the nominations were confirmed.

PROPOSED ALTERATION IN BYE-LAW.

The PRESIDENT said—I have now to give notice, on behalf of the Council, that, at the Closing Business Meeting of the Session, to be held in Newcastle-upon-Tyne, on Wednesday, May 18th, 1904, I shall move that the following alteration be made in Bye-law 12 (the alteration is printed in italics):—

"12. The result of the ballot for Officers shall be declared at the Closing Business Meeting, to be held in May, at which meeting general business shall be transacted. *The newly-elected Officers shall enter into office on the 1st day of August following; and the new President shall be installed at the Annual General Meeting in October.* (See Byelaw 47.)"

The purpose of this proposed alteration is that the year as regards officers shall terminate at the same time as the financial year, that is, at the end of July, and that the new officers will take office on the 1st of August, being the commencement of the new year; and also that the President, instead of being installed at the last meeting of the old session—a rather cheerless, cold operation—shall be installed at the first meeting of the new session.

The discussion on Mr. F. H. Alexander's paper on "Engine-room Bulkheads in Passenger Steamers" was resumed and closed.

The discussion on Mr. H. M. Wilson's paper on "Automatic Governing of Marine Engines" was resumed and closed.

Engineer-Lieut. E. F. Baker, R.N., read a paper on "The Management of Belleville Boilers at Sea."

DISCUSSION ON MR. F. H. ALEXANDER'S PAPER ON "LONGITUDINAL ENGINE-ROOM BULKHEADS IN MERCHANT VESSELS IN RELATION TO TRANSVERSE STABILITY WHEN BILGED."

Mr. J. H. HECK said—Mr. Alexander has brought forward a very interesting and important point in regard to the use of longitudinal bulkheads in the engine room, and to the effect such bulkheads would have on the stability if one side of the vessel was holed or bilged. In bad weather, if the rush of water was great and she heeled over to 30 degrees, the vessel would certainly be in great danger. With such or a greater list it would be difficult to carry on the work either in the engine or boiler rooms, and to fill the tanks on the other side, for the purpose of righting, would also be a question of time. One cannot help feeling that many engineers who know the conditions existing in an engine room when the vessel is rolling or pitching, or even in moderate weather, would prefer to go to sea in a vessel which had not a longitudinal bulkhead in the engine room, and had been so designed as to have ample stability even if this compartment was fully flooded. In large passenger steamers it is a question whether an extra transverse bulkhead in the engine room would not be of more value than a longitudinal bulkhead.

Mr. Alexander asks important questions on various points in connection with a holed or bilged ship and having a list of 30 degrees. It would be a very valuable and not over costly experiment to fill a large vessel, in the loaded condition and in still water, with water on one side of a longitudinal bulkhead in the engine room, and ascertain how work would go on in the stokeholds and engine room, how long it would take to get out all the boats, etc. Such an experiment would form the subject of a very instructive report in many ways, even although the conditions of still water would be so different from that of stormy weather in the Atlantic.

I quite agree with Mr. Alexander when, in reference to the longitudinal bulkheads in oil vessels and those having deep

tanks, he says, "In both these cases the bulkheads are in valuable daily use when the spaces are filled with liquid."

I therefore do not agree with the gentleman who opened the discussion, that longitudinal bulkheads could be dispensed with in deep tanks. In my opinion, in such tanks and in holds where liquid cargoes are carried in bulk, a longitudinal bulkhead is of considerable value, as it practically reduces the size of the tank. In this way the longitudinal bulkhead plays an important part, especially if the tanks are not full, in reducing the strain that is set up to balance the acceleration and retardation of motion that takes place when a vessel is rolling and pitching at sea. Its effect can be simply illustrated. If a tank 35 feet long by 1 foot square is full of water, the weight of the water is 1 ton and the pressure on the ends when the tank is still is 32 pounds. To put this tank in motion and to give it the acceleration due to gravity or, when in motion, the retardation due to gravity, would require a pressure of 1 ton on the ends. If, however, the tank has been divided by transverse bulkheads into ten divisions or spaces with similar conditions of acceleration or retardation, the pressure on the end would only be $\frac{1}{10}$ of a ton in place of 1 ton. This, of course, is a very simple case; the inference drawn from it, however, as to variation of strain or the reduction of strain by the use of bulkheads in virtually reducing the size of the tank, holds in all cases, no matter what may be the law governing the acceleration or retardation of motion.

In conclusion, Mr. Alexander's paper has certainly dealt with an interesting and important point in the question of practical stability.

MR. F. H. ALEXANDER'S REPLY.

Mr. F. H. ALEXANDER, replying to the discussion, said—As we have a long and interesting paper yet to be read this evening, I will try and condense my remarks as far as possible. Mr. Black's written communication pointed out that he had some years ago suggested the use of side pockets at the ends of a transverse bulkhead in order to reduce the chances of admission of water both before and abaft such bulkhead. This was news to me, and I am sure Mr. Black is entitled to every

credit for his suggestion: he does not indicate, however, whether the pockets are only at the sides of the ship, or whether they are connected by an open passage across the bottom, as suggested in my paper. I agree with him that such pockets are a protection, because it is not likely that such damage as Mr. Hogg refers to would take place; though of course it would be possible to have the bilge of the ship torn for so much of the length as to admit water into many compartments. Mr. Hogg raised certain questions which showed that he had given thought to the problem, and I will take those questions and answer them in order.

(1) If there were no longitudinal bulkhead, and both engine rooms were flooded all across the ship, then, assuming the length of the compartment to be 10 per cent. of the length of the ship, the metacentric height (G.M.) would be the same after bilging as before it.

(2) If the after engine room (Fig. 12, Plate XII.) and the hold abaft it were both flooded, then the G.M. would be 3 inches greater after bilging than before it.

(3) If the hold and an engine room on one side of a longitudinal bulkhead were flooded, then the G.M. in the upright condition might be said to be an inch greater after bilging than before it; but, of course, the inclination taken by the vessel is the important point in this case. It is a common opinion that bilging reduces the height of G.M., but this depends on circumstances. Although the moment of inertia of a damaged waterplane is reduced, and therefore the height of the metacentre above the centre of buoyancy is reduced, the centre of buoyancy itself may be raised nearer the centre of gravity by the sinkage due to loss of buoyancy, and this may more than counteract the above reduction: so that G.M. may be greater after bilging than before it. Of course the reduction of freeboard may reduce the range of stability although the initial stability may be greater.

(4) As regards the use of the ballast tanks to bring the vessel upright, I found that if a watertight fore and aft division were fitted from peak to peak throughout the double-bottom, and that the ballast tank was 5 feet deep at the centre, and filled entirely on the side opposite to that of the damaged engine room, the inclination would be reduced from 30 degrees to

15 degrees in the case where the G.M. was 1 foot. But surely Mr. Hogg does not venture to suggest that the filling of these tanks could be completed in three minutes; and if not, the vessel might have turned over. This was the reason I did not refer to the point in the paper.

(5) Mr. Hogg suggested at one place in his remarks that I recommend the approximate method of estimating the angle of heel, given in the paper; that is not so, for although it is one frequently issued by naval architects, I distinctly point out its limitations.

With regard to what Mr. Heck has said this evening, I am entirely in agreement with him. Mr. Hogg seemed to question the value of the longitudinal bulkheads in the deep tanks of broad vessels; but the paper, though not directly dealing with this subject, refers to these bulkheads as being in "valuable daily use" when the tanks contain liquid. I did not deal with the longitudinal bulkheads from the point of view of the strength they gave to the structure.

Perhaps I may be allowed to refer to the fact that one of the leading technical journals, in its current issue, has suggested that the overturning of the Russian battleship "Petropavlovsk" a few days ago, was due to the presence of longitudinal internal bulkheads. Now, I do not suppose we shall ever know the complete extent of the damage which caused the loss of that vessel, or how it took place, but I mention the suggestion because it has a bearing on the subject of the paper.

In conclusion, I wish to thank the Institution for the kind hearing they have given the paper, and to thank, also, the gentlemen who have so kindly taken part in the discussion.

The PRESIDENT said—I have great pleasure in rising to suggest that we convey our hearty thanks to Mr. Alexander for his most valuable paper, and those of us who have not taken part in the discussion have to thank our fellow members for the added interest they have given to it by their participation in the discussion. I think you will join me in conveying in the usual way our warm thanks to Mr. Alexander.

The proposal was carried by acclamation.

RESUMED DISCUSSION ON MR. H. M. WILSON'S PAPER ON "AUTOMATIC GOVERNING OF MARINE ENGINES."

The PRESIDENT said—I should like to ask Mr. Wilson a question. He says in his paper, "An efficient and reliable governor is one that may be depended upon to act with no greater increase in the number of revolutions than 5 per cent." A little further on Mr. Wilson refers to the Aspinall governor. We all know it is an excellent apparatus, but at the same time I think it is desirable that this point should be made clear. Mr. Wilson says it can be adjusted so that an increase of a revolution or two per minute will cause the governor to act. I take it, however, that what Mr. Wilson really means is that the Aspinall governor begins to act at from 1 to 5 per cent., but not that it governs to 5 per cent. acceleration. I can scarcely imagine any governor would prevent racing to so small an extent as 5 per cent. Has Mr. Wilson, as a matter of fact, any accurate data of what takes places in a seaway—whether the racing is 5 per cent., 15 per cent., or 20 per cent.? I am not speaking of the number of revolutions required to bring the governor into play, but the actual effect on the engines of the governor when it does come into play. We all know much depends on the nature of the valve which is operated by the governor. There are good valves and bad valves. It would be almost impossible from this paper to compare the action of any marine governor with what takes place on shore in land engines. The land engineers have a great advantage in that they can make experiments from which they get reliable data. Marine engineers have not got many such opportunities; and we should be grateful to Mr. Wilson if he would kindly give such data—such precise and accurate information as to the real behaviour of the governor at sea—such information as will enable engineers, young men coming on, to improve upon even the Aspinall governor.

Mr. TOM C. FORTUNE said—There are one or two remarks that I would like to make regarding Mr. Wilson's paper. I am

not going to say anything with regard to the different types of governors described in the paper, seeing that I have had no practical experience with them at sea; and am therefore not in a position to say whether any of them are either good, bad or indifferent. But as the main point in question is to increase the life of the tail shaft, it is to this that I will confine my remarks. Mr. Wilson mentions that the greatest shear stress in the shaft when the engine is running at 70 revolutions is about 5,000 pounds per square inch, and when running at 105 revolutions this rises to 8,500 pounds per square inch. There is, however, another stress acting in conjunction with the above, which, I fear, he has neglected altogether, viz.: the stress in the tail shaft due to bending, from the following causes. The tail shaft is a beam of the cantilever type, and the loads which cause bending are (1) the weight of the propeller and (2) the load due to the impact of the propeller striking the water suddenly, after having been lifted out of the same, due to the pitching of the vessel. As this bending stress is caused firstly in one direction when the stern of the vessel lifts, and secondly in the opposite direction when the stern of the vessel sinks, the latter in all cases being the greater, this action causes a reversal of stress to take place in the shaft, and is, in my opinion, productive of all the mishaps to tail shafts that we hear about so frequently, seeing that through time it sets up distress in the material, which distress is also actively assisted at the outer surface of the shaft where the stress is greatest, by the galvanic action of the sea water, and the shaft finally gives way, sometimes with disastrous results. The tail shafts of steamers should, therefore, in all cases be designed to resist bending as well as twisting. This is clearly shown by reference to the following formulæ, the first of which gives the stress in a shaft due to twisting, and the second gives the stress due to bending. Assuming, for instance, that the twisting and bending moments on a certain shaft were equal, it would be found, on substituting the various quantities in the formulæ quoted and solving the same, that the bending stress was 50 per cent. greater than the twisting stress, which, I think, clearly proves that the stress due to bending is the more important of the two, and is the one that is most detrimental to the life of the shaft, especially when it is constantly reversed. In the

face of the above, I think that the stresses quoted by Mr. Wilson are no criterion as to what the stress in the tail shaft really is.

FORMULA I.

$$f = \frac{T}{Z} = \frac{T}{\frac{\pi}{16} d^3} = \frac{T \times 16}{\pi \times d^3}$$

Where f = stress in shaft due to twisting.
T = torque on shaft in inch lbs.
Z = modulus of circular shaft to resist torsion.
π = 3·1416.
d = diameter of shaft in inches.

FORMULA II.

$$f = \frac{M}{Z} = \frac{W \times L}{\frac{\pi}{32} d^3} = \frac{W \times L \times 32}{\pi \times d^3}$$

Where f = stress in shaft due to bending.
M = binding moment on shaft in inch lbs.
W = load at end of shaft in lbs., treating it as a cantilever, and due to causes mentioned.
L = Length of beam in inches.
π = 3·1416.
Z = modulus of circular shaft to resist bending.
d = diameter of shaft in inches.

Mr. EDMUND WILSON said—One cannot but notice, when reading the papers submitted to this and similar institutions, how great a number of them under very different titles all deal in the main with one subject, viz., the accidents to propeller shafts. We have had papers dealing avowedly with breakdowns to shafting, papers on the ballasting of the modern tramp steamer, which resolved themselves into a discussion on the best way to ballast a ship to prevent accidents to the shaft, and now we have this paper of Mr. Wilson's dealing with the automatic governing of marine engines, in the very first paragraph of which he gets at once back to the old question of the accidents with tail shafts.

I had not the pleasure of hearing Mr. Wilson read his paper, but I have carefully gone through both it and Mr. Welbury's remarks. I have also read Mr. Welbury's paper, delivered in

London, and the discussion which followed. I have also refreshed my memory by reading up the numerous inventions which now are, and formerly were on the market and whose object is the prevention of racing.

After the perusal of these latter one wonders why Lloyds', B.T., B.C. and Bureau Veritas do not insert a clause in their rules to this effect:—"Engines fitted with so-and-so governor will be allowed a reduction of so much per cent. on all shaft diameters."

For read the evidence. One chief engineer writes:—"The governor has acted splendidly, and is a perfect remedy for racing," and the captain adds, "The vessel holds her course in the worst weather." Another engineer writes of another governor: "It worked splendidly. I have not seen any governor to equal it in any shape." Another says, he never used the throttle valve the whole passage, the governor anticipating every lift of the propeller. Another superintendent engineer thought a certain governor as near perfection as possible, and another says, "The governor never fails to do its duty." Now, I am sure, if the attention of the various classification societies could only be drawn to these evidences of racing prevented, they would immediately amend their rules and insert the clause I have mentioned.

At the beginning of his paper Mr. Wilson makes a reference to the combined action of the severe torsional stress and the galvanic action set up in the tail shaft, and proceeds to say, in reference to this galvanic action, that there have been many devices to prevent this wasting and corrosion by covering this part and allowing the tail shaft to be examined by cutting away the stern tube at places between its bearings, but with small success, and then he proceeds to explain that what you ought to do is to prevent that excessive racing which causes abrasion of the shaft and which so assists the alleged galvanic action.

Now, personally, I should say that the continuous brass liner, Donovan patent stern tube, Cederval's patent, and similar inventions had done more harm to the manufacturers of tail shafts than any automatic governor. But this is by the way. Neither Mr. Wilson nor Mr. Welbury have spared the unfortunate marine engineer nor the superintendent for their

gross neglect of so important a subject as the automatic governing of marine engines. But is not this charge a little overdone? Very numerous have been the governors brought to the notice of the marine engineer, every one of which has had devoted to it the experience, skill and ingenuity of one or more engineers, many of whom, no doubt, have had abundant practical experience of the conditions under which a marine governor has to work. And, according to the evidence which I previously read, the governor has been found—about half a dozen of them—only it is so difficult to persuade the great body of superintendents and owners to have them put in.

I should now like to follow Mr. Wilson and Mr. Welbury a little in their investigations into the governing of stationary engines to see what may be learned to assist us in the governing of marine engines. While quite admitting that a good deal may be learned in this way, I am convinced we will learn a good deal more, and arrive at a satisfactory practical conclusion a good deal sooner, if we keep constantly before us the enormous differences which must and always will exist between land and marine engines. Mr. Welbury gave some examples of rough tests, which showed a variation of only about 3 per cent., which, as he says, is very fine governing; and then he turns to the body of marine engineers in general and says, referring to some figures he read, "Why cannot you have similar accurate figures? Why do you not know what speed your propeller goes when it comes out of the water? It will only cost you £10 for a tachometer and you can read your speed on the dial at any time.

Now, when these tests were being made, which showed only a variation of 3 per cent. when loads were being switched off and on, if it had been possible for some person quite unconnected with the tests department to suddenly remove the flywheel and as suddenly replace it and do this several times, you might have something similar to the conditions you have when a marine engine races and I am afraid the variation would be more than 3 per cent.; and, as for putting a tachometer on, my experience with a tachometer on a marine engine is that it is of very little use. You might certainly by very careful watching be enabled to get a rough id of the revolu ns e was making, but only very rough, as t er get settled down.

Mr. Welbury says, "I do not believe myself that you will ever govern a marine engine without you use some other means than throttling. You must have something to replace the flywheel or compensate for its absence." Now, in my opinion, the marine engine has a flywheel in the propeller and that propeller stores up energy when in the water and gives it out when in the air, the very time we do not want it.

So that what we want is not something to replace the flywheel or compensate for its absence, but something to compensate for the flywheel coming into action at the wrong time. It would be unjust for me or anyone to attempt to pass judgment on many of the numerous governors mentioned by Mr. Wilson in his paper. To do justice to most of them one must have had a considerable experience of them at sea.

As Mr. Welbury truly says in his paper read in London, "The governor is more a subject for experiment than for mathematics; the friction of a joint, or a stuffing box, is liable to upset the most careful calculation." This being so, I would like to make a few observations on racing of marine engines in general, based on my own experience of the kind of work which an ordinary steamer has to perform in her journeyings over the North Atlantic in ballast trim (alleged). When we speak of racing we mean the running away of the engines at a speed very much above the normal, when the propeller is partly or wholly out of the water.

Now, this running away of the engines is not in itself such a very great evil as some people would have us suppose, in so far as the injury to the tail shaft is concerned. A well-designed, well-built engine, well cared for, will run at speeds far in excess of the normal, and take very little harm from that. The harm that comes to tail shafts when an engine is racing heavily is, it seems to me, not due to the racing, but to the very severe bending stresses which the shaft is subjected to when being alternately lifted out of the water many feet and then dropped suddenly down into it again; for these stresses exist when the ship pitches, even when the engines are stopped, and consequently no governor ever invented can have the least effect on them.

So I am afraid that to get the classification societies to relax a little in the matter of shaft diameters we will have to do

something else than fit a governor. Mr. Chaston would probably say, and he would be quite right, "Ballast the ship properly."

I am far from condemning all governors. All that is required of a governor is to fairly well perform all the duties which an intelligent man at the throttle would do. This I am quite convinced many of the governors now on the market will do, when well cared for and kept in good order.

The next generation of marine engineers will, no doubt, greatly admire the ingenuity displayed in the design of governors for controlling the erratic movements of the shaft. They will have still greater admiration for the marvellous ingenuity and skill displayed and the truly wonderful results achieved by the present race and their predecessors in their endeavours to obtain a satisfactory rotary motion from a piece of machinery which, in its first principle, is so closely allied to a quartz crusher or a steam hammer. But surely the greatest honour will be accorded that member of this Institution who has produced (not on paper but working every day) a marine engine which is bound from the very principles of its construction to suffer less from racing than any other type. And yet Mr. Charles Parsons, not content with producing an engine which in my opinion suffers very little from racing, has also produced and fitted on the two cross channel steamers now running, a governor which it may be of interest to here briefly describe.

Each of the three turbine shafts is fitted with a worm which drives an ordinary Proell governor, which when the shafts attain a certain speed opens a communication between the condenser and the underside of a piston which controls the regulator valve and so closes this valve until the revolutions again attain the normal.

Personally, I consider that a governor for a marine turbine engine is a little unnecessary, except as an emergency gear, and that with the small and light well immersed and perfectly balanced propellers, fitted on this type of engine, any boat suitable for the Atlantic trade will be able to run over in very bad weather, without the engine room staff having to suffer the horrors so well described by Mr. Wilson and Mr. Welbury, and yet without an automatic governor.

Mr. David Andrew said—I expected some of our members who have had more recent experience of governing engines at

sea would have taken part in the discussion of this very important subject, as I am afraid my experience will be looked upon very much in the light of ancient history, going back as it does into the sixties. My first recollection of a governor, the name of which I have forgotten, was put on board to control geared steeple engines making about 25 revolutions with a boiler pressure of 15 to 20 lbs. It was a heavy, cumbersome governor, having an arrangement of weighted arms, which flew out when the engines raced, closing the throttle valve. There was nothing anticipatory about it, as the engines had to race before it acted, and the momentum it then gained kept the valve closed until the engines were practically stopped, rendering it necessary to throttle the injector by hand to prevent the condenser getting filled. Latterly it came to be a very neglected part of the outfit.

The "Silver" governor I recognize as an old friend, a great favourite at that time, and a very useful governor. In the first place it controlled the engines fairly well when heading or running before a long true sea, the racing coming on gradually, and leaving in the same manner, therefore it did not require to be anticipatory; but in a heavy gale, with a high breaking sea, it failed to anticipate the sudden racing of the engine, due to the quick movement of the vessel. Under those circumstances it was too late in closing the throttle valve to prevent sudden racing. In the second place it was very useful as a punkah when kept running in sultry weather, the vanes on the flywheel keeping the air in circulation.

A governor, to be thoroughly effective, should, if it were possible, anticipate the racing in a high breaking sea and close the valve just prior to the propeller suddenly clearing the water. But Mr. Wilson says:—"However tight the throttle is shut down, and the engine gets away, the vibration will be increased owing to no steam being in the cylinders to speak of, or what got there would be all swept out in one revolution, after the valve was closed." In my opinion when this occurs it would prevent, or at least minimise, racing. Again, Mr. Wilson says:—"When running at their normal speed this is not the case. If the throttle is shut soon enough all vibration is done away with, and also the excessive twisting strains in the shaft." Aye, there's the rub! If the throttle is shut soon enough! Does Mr.

Wilson mean shut tight down or left partly open? If the latter, I am afraid it would assist the racing by admitting steam into the cylinder at that particular moment.

I differ from Mr. Wilson in his statement "that it is out of the question and impossible to properly govern or stop the racing of marine engines by hand, so that the engines in a rough sea and light ship may be kept going at the normal or fine-weather revolutions and the steam-pressure and valve-openings also normal. Every engineer will tell you that when racing threatens the pressure of steam is reduced, and naturally the revolutions, to about half. Even then the engine has an occasional race. No engineer can with certainty anticipate an acceleration; he may do so for a time until at last he closes the throttle valve too soon or opens it too late."

From my own experience I consider it is possible, and certainly an engineer can anticipate the sudden racing much better than a governor. The movement of the vessel will indicate to him what to expect, for when the vessel rises higher than usual forward and the engines are working below their normal speed he knows that when she tops the sea the stern will rise suddenly throwing the propeller clean out of the water. This he can anticipate, and close the throttle before it takes place and check racing quite as much as the governor can do, and the stern settling down will clearly indicate when to open the valve so as to maintain the speed.

A thoroughly reliable anticipatory governor that could minimise the danger and anxiety of racing would, I am sure, be welcomed alike by superintendent and sea-going engineers, and if the particular governor mentioned by Mr. Wilson does one-half of what he claims for it, then it has filled up a long-felt want.

MR. H. M. WILSON'S REPLY.

Mr. H. M. Wilson replied on the discussion. He said—Mr. Welbury at last meeting, March 25th, called attention to some remarks made in reference to what he said before the Institute of Marine Engineers on February 9th of last year at Stratford, upon the Aspinall governor, which will be found at the end of the description of that governor in the paper just read, and which we are discussing this evening. If you get a copy of the

minutes of that honourable body you will there find (vol. xiv., p. 41) that there is nothing to withdraw from what has been said. Though he begs to differ, in the whole he seems to agree, especially when he complains about no figures being quoted. He practically admits that there are no instruments on board to give the speed at which marine engines run when the propeller comes out of the water, and suggests tachometers being used.

I wrote Messrs. Aspinall regarding the points in question brought forward and have elicited the following reply:—"In reference to the remarks that we dare not close the throttle valve entirely, we wish to point out that if the throttle valve is perfectly designed (allowance made for expansion, and the valve fitted in a spindle passing through glands on both sides of the chest) there is no reason whatever why the throttle valve should not be full shut, if it is of the all-round type.

"The Aspinall governor can have its connections so arranged that it would be impossible, in our estimation, to have more efficient governing. The method is as follows:—In addition to the main steam throttle valve, fit a throttle valve in the intermediate eduction pipe or passage; also in the low pressure eduction pipe. (The throttle valve in the eduction pipe should have a fair amount of clearance, so that the pressure in the casing may not get too high.) These three valves should be connected up to governor, and when they are closed by the governor there is no doubt that the engines will be most efficiently checked. This system has been most successfully applied, with the result that another steamer is now being fitted in a similar manner.

"Everybody agrees in saying 'brains cannot be put into a governor,' and that 'the man at the throttle is apt to make a mistake,' but we claim that our governor cannot make a mistake, as if it is kept in thorough working order, it is bound to act on the slightest acceleration of the engines above the normal speed."

On glancing through the minutes of the Institute of Marine Engineers just described, I see the Aspinall governor quoted by nearly all of the speakers in the highest praise, and in fact the argument seems to principally turn upon that governor more than any other, which says more for it than anything else.

As regards the rigidity of the gear, Messrs. Aspinall make them either rigid or not, but the rigid is preferred, for it is more sensitive and is much quicker in action. No one even by hand will think of banging a throttle valve of the ordinary type against a face, for the sake of the valve and spindle. In new engines of the present high pressures, with a tight-fitting valve and a gland or stuffing-box on one side only, the valve often seizes and cannot be opened unless the regulator or stop valve is shut down. Again, as to closing in one revolution:—You cannot compare a marine-engine with a land-engine in regard to governing, as the former will in certain seas suddenly increase its revolutions at an enormous rate, when free from any resistance of the water, in less than a second, and in the governor in question, when it is set to its normal running, an increase of one revolution is hardly perceptible, which is remarkable, to say the least of it.

A land engine is mounted with a heavy flywheel and in consequence its accelerations are gradual, even from full load to none at all, and the governors adopted have timely warning and answer the purpose admirably, but they are entirely useless for marine engine governing and would go to pieces the first time they came into action in an ordinary rough sea. The land governor gradually closes or opens the throttle and then keeps the engine at a practically regular speed.

The marine governor, instead of closing down gradually as in land engines, must, by the quickest method possible, shut the valve at once on the least tendency to increase its accelerations and as quickly open again to keep the speed normal, as it were, by a series of puffs instead of a gradual diminution or increase in steam opening. It has been found by a pressure gauge in the main steam pipe on the boiler side of the throttle valve that there is no perceptible increase in pressure however quickly you shut the valve when an engine is kept up to its work. In a marine engine there is enough reduced pressure to save all shocks until the governor opens the throttle again, though not sufficient to let it get away.

In engines where the revolutions increase after the throttle valve is closed by the governor, Messrs. Aspinall have always found a remedy. It arises from several causes: (1) An ill-fitting throttle valve; (2) a throttle valve badly worn, and these

With the engine working steadily at the normal speed and the throttle shut properly at the increase of no more than 5 per cent. or 3 revolutions in 60, and opened again directly the normal is reached again, the vibration is done away with and also the excessive twisting strains on the shaft.

The PRESIDENT—We must accord to Mr. Wilson a hearty vote of thanks for his paper. Those who are in favour will please signify their concurrence in the usual way.

The proposal was carried with acclamation.

NEWCASTLE-UPON-TYNE,
May 4th, 1904.

DEAR MR. DUCKITT,

In answer to the President's question of last meeting, Messrs. Aspinall inform me they guarantee that their governor will act at 5 per cent. above the predetermined speed in engines running at 60 to 70 revolutions. The large weight of the governor begins to "float" a few revolutions before the shut-off speed is arrived at; therefore, the afore-mentioned 5 per cent. is allowed to ensure this weight remaining at rest when the engines are running at their normal speed; otherwise, if there was no margin the weight would be continually knocking, causing annoyance to those in charge and unnecessary wear and tear of the governor itself.

In actual practice the revolutions do not increase above 5 per cent. in heavy weather, but when a shaft breaks (which is equal to the full load being taken off) the increase tends to at least double the normal with a very sudden rush and rapidity which brings the emergency weight into action and locks the whole as before mentioned.

Yours faithfully,
H. M. WILSON.

THE MANAGEMENT OF BELLEVILLE BOILERS AT SEA.

H.M.S. "GOOD HOPE."

By Engineer-Lieutenant E. F. BAKER, R.N., Member.

[Read in Newcastle-upon-Tyne, on April 22nd, 1904.]

So much has been said from time to time to the discredit of the Belleville boiler that one almost wonders how it is that ships fitted with them are able to steam at all, and yet in spite of the prophesies of those "who know," ships fitted with these boilers set out on voyages to all parts of the globe, and not only reach their destinations, and come back again, but are ready to repeat the programme.

That there is a certain amount of perverseness about the Belleville boiler cannot be denied, but it has been proved over and over again that as long as it is reasonably treated it will do its work in return.

As it has been thought that the experience gained with these boilers in H.M.S. "Good Hope," and the treatment arising out of this experience might prove of interest to the members of the North-East Coast Institution of Engineers and Shipbuilders, the following remarks have been compiled and are now submitted for their consideration.

H.M.S "Good Hope" is a first-class armoured cruiser of 14100 tons displacement, and 30,000 I.H.P., which is intended to give the ship a speed of 23 knots.

Steam is supplied by 43 Belleville boilers fitted with economisers, and designed for a pressure of 300 pounds per square inch. The boilers are arranged in eight groups, as shown in sketch (Fig. 1, Plate XX.), the groups being distinguished by letters, and the boilers composing each group by numbers. The composition of the different groups is as

Group A consists of two 10-element boilers.
Group B consists of two 9-element and four 8-element boilers.
Group C consists of three 10-element boilers.
Group D consists of two 9-element and six 8-element boilers.
Group E consists of four 9-element boilers.
Group F consists of eight 9-element boilers.
Group G consists of four 9-element boilers.
Group H consists of eight 9-element boilers.

Under ordinary conditions a pressure of from 225 lbs. to 250 lbs. of steam was kept in the boilers, giving from 200 lbs. to 225 lbs. pressure in the engine room.

When the ship was first commissioned, the maintenance of steam and the details as to cleaning fires were in a large measure left to the chief and leading stokers, who received their orders from the officer of the watch as to the pressure to be kept, the thickness of the fires, and the number of fires to be cleaned each watch. As the ship is not fitted with reducing valves (like some of the earlier Belleville ships) this arrangement proved most unsatisfactory.

Most of the men, having just come out of ships fitted with cylindrical boilers, treated the Belleville boilers as they were accustomed to treat the former. When the pressure dropped, everybody fired up, with the result that it went up with a run, as also did the coal consumption. This method of stoking was accompanied with clouds of smoke. Then the firing would cease, and in a short time the pressure would drop as fast as it had previously risen, and the same performance would be repeated with the same unsatisfactory results.

Again, the men would wait until the pressure was up before cleaning fires, when several would be started at once, with the natural result of a rapid falling of the pressure, and then some of the fires would be scamped, and the next watch would have more than their proper share to clean, and probably the steam would be down all the watch. The variation in the steam pressure and the consequent irregularity of the feed, as well as the quantities of smoke made were at times considerable, owing to the difficulty of effectually controlling the work

of the boilers. The irregularity in the steam pressure under these conditions is not surprising when one compares the quantity of water under treatment in the cylindrical and Belleville boilers respectively.

The following particulars offer a comparison between a cylindrical boiler and two Belleville boilers of similar evaporative power, as far as the quantity of water dealt with in each case is concerned, and the quantity represented by 10 inches in the gauge glass. To make the comparison as fair as possible, the grate area has been taken as nearly equal as possible, and in the case of the cylindrical boiler the water below the centre of the lower furnaces has not been included.

PARTICULARS OF BOILERS.

Cylindrical Boiler—

Diameter	15 feet 6 inches.
Length	9 feet 6 inches.
Maximum diameter of furnaces	3 feet 7½ inches.
Number of furnaces	4.
Grate surface	95·6 square feet.
Diameter of tubes	2½ inches.
Length of tubes	6 feet 3 inches.
Number of tubes	538.
Water dealt with at working height	390 cwts.
*Water represented by 10 inches in the gauge glass	58 cwts.

Two Belleville Boilers—

Diameter of generator tubes	4 inches.
Length of generator tubes	7 feet 6½ inches.
Number of elements	16.
Grate surface	96·7 square feet.
Water dealt with at working height	46·3 cwts.
*Water represented by 10 inches in the gauge glass	21·7 cwts.

The ratio of the quantity of water under treatment in the Belleville boiler to that in the cylindrical boiler is therefore as 1 is to 8·42. As a matter of fact the difference is probably

* The difference between the quantities represented by 14 inches and 4 inches in the glass.

boiler per hour. The procedure then was to read off the diagram the total number of skids of coal corresponding to the revolutions ordered, to divide this quantity by the number of boilers in use, which gave the number of skids per boiler per hour. By consulting the table the officer of the watch could then determine the number of shovels-full to be fired at a time, and the interval of time between each firing of the same furnace.

The order for firing was given by ringing gongs in the stokeholds at the required intervals. Now there are two ways of giving the time: (1) by sounding the gong for each furnace, and (2) by sounding the gong when a round of all the furnaces was to be commenced. The latter way was adopted as it was found simpler to arrange, and was easily applied to groups composed of different numbers of boilers.

The following were the objections to the former:—In the first place it involved continual bell ringing, and consequently increased the chances of confusion; secondly, it was necessary for the stoker to be continually on the alert for a bell to ring for each furnace, and in the event of any diversion, such as his attention being taken away by, say, a skid taking charge in the stokehold, etc., he might miss hearing the bell and consequently one or more intervals would be dropped. But the principal objection was due to the different composition of the various groups. Thus, for instance, suppose the ship were steaming with, say, A, C, and D groups.

The composition of the groups is as follows:—

A—1 and 2 with 6 furnaces.
C—1, 2 and 3 with 9 furnaces.
D—1, 2, 3 and 4 with 12 furnaces.
D—5, 6, 7 and 8 with 12 furnaces.

If a furnace was fired up each time the gong was sounded, and the rate of combustion of the D group was x lbs. per square foot of grate per hour, then the rate of combustion of the A group would be $2x$ lbs. per square foot of grate, and of C group $= \frac{12}{9} x = 1\frac{1}{3}x$ lbs. per square foot of grate.

The matter could be rectified by firing up A group with every other ring, and with the C group passing every fourth ring; or else by firing a furnace each time the bell rang till

they had all been fired, and then allowing six rings to pass with the A group and four with the C group.

Both arrangements introduce complications and make an opening for disobeying orders—a proceeding which must always be avoided.

In the first case a man, by having his attention suddenly taken up with something else, or being by nature tired (a disposition not altogether unknown in the Navy), might skip three or four rings without being found out, and when found out might deny that he had done so, or plead ignorance.

The second alternative has this additional disadvantage, that firing up all the furnaces, and then pausing, does not tend to impress upon the stoker the great principle underlying the management of these boilers, namely, regularity of treatment.

The same difficulty as to the composition of the different groups also arises when only a portion of either E, F, G, or H groups is in use, and not all four boilers composing the group.

The timing was at first attempted by means of a clock which, at the required intervals, completed the stokehold bell circuit. Some difficulties were experienced with this clock, which in time were overcome, but the bells proved unequal to the task. In the first place they were not powerful enough to be heard above the noise of the stokehold, added to which in time they showed signs of fatigue.

Instead of these bells, gongs made of four feet lengths of solid drawn steel boiler tubing were used, which were hung up in the stokeholds in use, and were sounded by a stoker provided with an engine-room clock for keeping the time. Two stokers were told off for firing each group of four boilers; one attended to Nos. 1 and 2, the other to 3 and 4. To distinguish them they will be referred to as A and B.

The furnaces were numbered from left to right, commencing with the left hand wing furnaces, then the centre ones, and then the right wing furnaces. The numbers of the furnaces are shown on Figure 1 (Plate XX.) in front of each furnace.

The mode of procedure was as follows:—On the gong being sounded, A fired up Nos. 1 and 2 furnaces with the number of shovels-full ordered; then he sang out, "three and four," which B fired up. On completing No. 4 furnace B sang out, "five and six," which A fired up, and so, passing the word from one to the

other, A and B completed one round of firing of all the furnaces in the group of boilers. A would then wait till the gong sounded again, when another round of firing was commenced, and carried through in the same manner.

In order to ensure the utmost regularity it was impressed upon the men that the interval between successive furnaces should be as equal as possible, *i.e.*, the interval between Nos. 11 and 12 equal to that between 12 and 1, or 1 and 2, etc.

The firing, and consequent steam pressure were entirely controlled by the officer of the watch, who obtained the particulars of the firing in the first instance from the diagram, and then varied the interval of time between each round of firing to suit the steam pressure.

The most convenient pressure gauge for the adjustment of the interval was found, in this case, to be the gauge of the auxiliary steam service, which, being less liable to sudden fluctuations of pressure than the main steam gauges, gave more approximately the mean pressure of all the boilers in use. With the liberal allowance of coal (2·5 lbs. per I.H.P. per hour), the interval of time had to be lengthened out as the pressure went up, but the error was on the right side. As a matter of fact the interval of time was never kept constant for a long stretch of time, but was increased and decreased from time to time by half a minute or more, resulting in a very easy fall or rise of pressure.

In this way the worry about the steam pressure was taken off the chief and leading stokers, except as far as working the draught plates was concerned, which, however, when once the proper opening to suit the rate of combustion had been found, required but little alteration. The principal items to which the leading stokers had to attend were:—

(1) That the proper number of shovels-full were fired at a time.
(2) That the furnaces were fired in succession as numbered.
(3) That each round was commenced when the gong was sounded, and completed before it was sounded again.
(4) That the interval between the rounds was equally divided up between the furnaces.
(5) That the fires were kept level and the grate uniformly covered.

The diagram, Figure 2 (Plate XX.) was, after a time, discarded, as, although fairly correct at low speeds, it was in excess of the coal required at the higher speeds. This was due to the addition of the coal used for auxiliary purposes, which at low powers is a considerable fraction of the total quantity, this fraction becoming smaller as the power increases, and consequently the consumption in pounds per I.H.P. per hour becomes less at the same time. This led to the diagram Figure 3 (Plate XXI.).

On this diagram the coal for the main engines is plotted out at 1·5, 1·6, 1·7, 1·8, 1·9 and 2 lbs. per I.H.P. per hour. The auxiliary coal, amounting to 1 ton, or 8 skids per hour, was added to the coal for the main engines, which gave the total coal for all purposes. Any additional machinery above the auxiliary machinery generally in use had also to be added, such as dynamos, hydraulic pumps, extra evaporators, etc.

The coal for auxiliary purposes and additional engines is given at the top of the diagram, and has been obtained by actual trial. Unfortunately, by October last the only reliable trial results available were those of the auxiliary coal under ordinary conditions, and a dynamo at full load. The total coal thus found was divided by the number of boilers in use as before, and the particulars of firing to suit obtained from the firing table. In addition were given speed and revolution curves to enable the coal to be determined with either the speed, power, or revolutions given.

Thus given the speed, by following the speed line across to where it cuts the revolution curve, and then down along the revolution line, the revolutions could be read off the revolution scale, and up again along that line to the coal curves, the coal could be read off the right-hand scale thus:—

(1) Given speed = 16·5 knots.
Revolutions = 79 per minute.

	Per I.H.P. per Hour.	Skids for Auxiliary Purposes.
Skids of Coal for main engines at 2 lbs.		= 53 + 8 = 61
Do.	1·8	= 48 + 8 = 56
Do.	1·6	= 43 + 8 = 51

Given the power, by following up the power line to the speed curve; along the speed line to the left, the speed could

be read off; along to the right to the revolution line and down, the revolutions could be read; up along the line again to the coal curves and along to the right, the coal could be read thus:

(2) Given power = 6,500 I.H.P.
Speed = 15·7 knots.
Revolutions = 75·5 per minute.

	Per I.H.P. per Hour.		Skids for Auxiliary Purposes.
Skids of Coal for main engines at 2 lbs.		= 46	+ 8 = 54
Do.	1·8	= 41·5	+ 8 = 49·5
Do.	1·6	= 37	+ 8 = 45

The next step was to do away with the dividing, for which purpose the slide rule, illustrated in Figure 4 (Plate XXII.) was made. On the left hand of the slide are the logarithms of the numbers of skids per hour to scale, and alongside the number of skids the corresponding revolutions per minute. On the slide are, to the same scale, the logarithms of the numbers of boilers in use from 8 up to 43. On the right hand side are the logarithms of the number of skids per boiler per hour, with the rate of combustion in pounds per square foot of grate, and the corresponding intervals of firing, using 2, 3, 4, 5 and 6 shovels-full at a time.

This rule, which was only intended for rapidly determining the particulars of firing, was made out on the basis of 2·3 lbs. per I.H.P. per hour for all purposes, and consequently shared the same defect with diagram Figure 1 (Plate XX.), with this difference, that the coal was under-estimated at the lower powers, whereas at from 12 to 16 knots it was fairly correct. To rectify this the left-hand column should be the logarithms of coal for main engines at 2 lbs. per I.H.P. + 8 skids. For convenience the zero on the slide was made to correspond with the mark "8."

To use the rule, the slide was moved down till the mark on the slide corresponding to the number of boilers in use was in line with the mark of the revolutions ordered, when the mark "8," or zero, corresponded with the mark of the skids per boiler per hour, pounds per square foot of grate, and firing intervals on the right hand side of the rule. The particulars of the firing could by this means be obtained at once without reference to any diagram.

At steam tactics, when the speed might vary from say 8 to 16 knots, the following scheme of controlling the firing was found convenient:—The interval of time was not altered, only the number of shovels-full to suit the revolutions. Use was made of the stokehold telegraph to indicate the numbers of shovels-full to be used.

On the stokehold telegraph were six divisions marked "voice pipe," "full speed," "half-speed," "slow," stop," the sixth being a blank. The second, third, fourth and fifth divisions were used with the following interpretations:—

"Full speed"—Fire up 6 shovels-full, and then drop down to 5 when the steam has been got hold of.
"Half speed"—Fire up 4 shovels-full.
"Slow"—Fire up 3 shovels-full.
The blank space—Fire up 2 shovels-full.

With the telegraph at "stop," the fires were sprinkled as required to keep the bars covered, when the gong was sounded.

As at steam tactics the safety of the ship may be endangered by a failure to carry out the orders promptly, it was left to the discretion of the chief stokers to add an extra shovel-full or two if the steam commenced to drop until they had got hold of it again. In the engine room the procedure was as follows: Say the maximum speed ordered was 16 knots, the number of boilers in use being 16. By the slide rule the firing for 80 revolutions came to 5 shovels-full every 9·78 minutes (say 9¾ minutes).

Firing 4, 3 and 2 shovels-full at the same interval, the corresponding revolutions came to 74, 66 and 56 per minute. Then for 80 revolutions the telegraph was put at "full speed" for 66-74 revolutions, at "half speed"; for 56-66 revolutions at "slow"; and for 45-56 revolutions, the blank space. If the revolutions ordered were say 60, for which 3 shovels-full were too much, and 2 not sufficient, the stokehold telegraph would show 3 shovels-full, with the result that the steam would go up. It was in these cases left to the discretion of the chief stoker to have a round or two of 2 shovels-full, and then carry on with the 3 again.

Cleaning Fires.

During the early part of the commission the fires were thoroughly cleaned by burning them down, shutting off the boiler, removing all the dirt and clinker, relighting the fires, and connecting up the boiler when ready. This, however, was found unsatisfactory on account of the time wasted, so instead of shutting off the boiler and cleaning the furnaces right out, the boilers were kept connected, and only one furnace cleaned at a time.

On the face of it this arrangement looks simple enough, as all the left-hand furnaces could be cleaned in one watch, the centre ones in the next, and the right wing in the third. This would give an interval of 12 hours between each cleaning. The objections were, especially when steaming with a large number of boilers, that a petty officer might easily by mistake clean the wrong fires in a group, and so upset the order of cleaning. It was also found that the burning down and cleaning was too slow a process, often considerably affecting the steam pressure, added to which, unless seen to, the bars immediately in front of the doors alone were cleaned, the spaces between being left untouched. Eventually this arrangement was given up, and the old one of dealing with all the furnaces of a boiler at a time adopted again, with this difference, that instead of burning down and cleaning, the fires were kept going all the time, and clinkered instead. By this means the fires could be kept as clean as was required for efficiency as long as the coal lasted; or, in other words, before the fires got so dirty as to require thoroughly cleaning the coal round about the group was as low as it was considered advisable to work it to.

In the event of a single group only being lit up in a boiler-room, and consequently there being plenty of coal to use, it was found cheaper, in the long run, to let the group out after about four days' steaming and light up another group. The group could then be thoroughly cleaned and got ready for lighting up again.

The question of coal supply and the selection of the boilers for steaming will be dealt with later.

Owing to limited space, the number of men that could be worked in a stokehold was also limited, and in order to get the

clinkering done expeditiously it was found advisable to institute a regular routine for clinkering.

Each group of four boilers was manned by a party of four stokers under a petty officer.

For convenience the stokers will be distinguished by the letters A, B, C, and D.

A and B have been dealt with as far as the firing is concerned. The duties of C and D were to get out coal, assist with the clinkering, and draw and send up ashes. It was left to the petty officer to tell off the hands so as to work in the changes at the fires, and the getting out coal.

When one of A's boilers had to be clinkered, the clinkering was done by A, assisted by either C or D, while B fired up *all* the furnaces *in their proper order* except the one actually being dealt with by A.

Before commencing a boiler the leading stoker would see that there was sufficient coal alongside the boiler for firing up after the clinker had been drawn, as well as for the remaining three boilers. A commenced with the left-hand furnace by pushing the good fire back and to the right, loosening the clinker with the slice and pulling it out with the devil. After all the clinker had been removed, the fire was drawn back and spread over the bars, and C (or D), who had been holding the shovel up before the furnace to keep the heat off A, fired up until the grate was properly covered. He would then clear away the clinker from in front of the furnace and move the remaining coal along ready for firing up the next furnace after the clinker had been drawn from it and the fire respread over the bars. This gave A a spell before starting the centre furnace, which was dealt with in a similar manner, as also the right-hand furnace. By having the men told off in this way the clinkering took very little time, as each man knew exactly what he had to do.

The result proved quite as good as when the fires were burnt down and thoroughly cleaned out, and it was less expensive.

The next thing to be considered was the interval between clinkering a boiler. At the start the interval chosen was every eight hours, which on a passage worked all right, as the rate of combustion was from 14 to 17 lbs. per square foot of grate,

but when manœuvring with a squadron at a low speed, with a few knots in hand, the interval was found too short and led to waste, so it was lengthened out to twelve hours.

This arbitrary way of determining the interval between the clinkering was not considered satisfactory, and the matter was gone into, resulting in the following formula:—

$N = \frac{YX}{30}$ where N = the number of boilers to be clinkered each watch.

„ Y = the rate of combustion in pounds per square foot of grate.

„ X = the number of boilers in use.

This is based on the assumption that at a rate of 15 lbs. per square foot of grate per hour the fires require clinkering every eight hours, and that the interval should vary inversely as the rate of combustion.

The proof of the formula is:—

The interval between clinkering $= \frac{15}{Y}$ 8 hours.

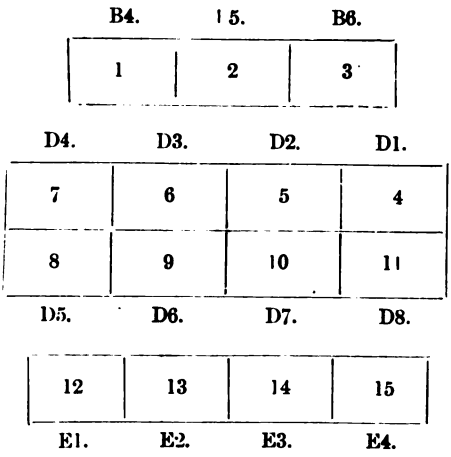
The number of fires to be clinkered a day $= \frac{24}{\left(\frac{15}{Y} 8\right)} \times X = \frac{YX}{5}$

The number of fires to be clinkered each watch $= \frac{\frac{YX}{5}}{6} = \frac{Y}{30}X$

Having determined the number of fires to be clinkered in each four hour watch, a rough sketch was made of the boilers on a slate, and the boilers were numbered from left to right, commencing forward. First the odd numbers of boilers were taken, amounting to $\frac{XY}{30}$, but should there not be sufficient odd numbers, the difference was made up with the even numbers commencing with the lowest.

The following is an illustration of the procedure:—Given the ship steaming with B 4-6, D 1-8 and E 1-4. Rate of combustion 18 lbs. per square foot of grate per hour then $N = \frac{18 \times 15}{30} = 9$, the number of boilers to be clinkered each watch.

SKETCH OF BOILERS.



LETTERS AND NUMBERS OF BOILERS TO BE CLINKERED DURING THE DIFFERENT HOURS OF THE WATCH.

Watches.	Hours of the Watch.			
	1st Hour.	2nd Hour.	3rd Hour.	4th Hour.
1st Watch	1, 3 = B4, B6	5, 7, 9 = D2, D4, D6	11, 13 = D8, E2	15, 2 = E4, B5
2nd ,,	4, 6 = D1, D3	8, 10, 12 = D5, D7, E1	14, 1 = E3, B4	3, 5 = B6, D2
3rd ,,	7, 9 = D4, D6	11, 13, 15 = D8, E2, E4	2, 4 = B5, D1	6, 8 = D3, D5
1st ,,	10, 12 = D7, E1	14, 1, 3 = E3, B4, B6	5, 7 = D2, D4	9, 11 = D6, D8
2nd ,,	13, 15 = E2, E4	2, 4, 6 = B5, D1, D3	8, 10 = D5, D7	12, 14 = E1, E3
3rd ,,	1, 3 = B4, B6	5, 7, 9 = D2, D4, D6	11, 13 = D8, E2	15, 2 = E4, B5

ORDERS TO CHIEF STOKER. 1ST WATCH.

1st hour	clinker	B4 and B6
2nd	Do.	D2, D4, and D6
3rd	Do.	D8 and E2
4th	Do	E4 and B5

The interval of clinkering is seven hours with an occasional six-hour interval. As the equation for clinkering involves multiplication and division, it might also be included on the slide rule, and so the process be further simplified.

Of course as in the case of the firing this was not intended to be a hard and fast rule, and just as the officer of the watch altered the firing interval to suit the steam, so the senior engineer-lieutenant altered the constant of the clinkering equation to suit the quality of the coal.

As guides both these rules were very useful, but especially when steaming with two or three knots in hand, and altering revolutions from time to time.

Coal Supply.

Reference was made, when dealing with the clinkering, to the coal supply, and the effect of the distribution of the coal on the working of the boilers.

From the sketch of the bunkers (Figure 5, Plate XXIII.) it will be seen that the following quantities of coal are available for the different boiler rooms:—

No. 1	Boiler room	...	...	457·5 tons	+	76 reserve	=	533·5	tons.
No. 2	Do.	...	...	...	...	...	...	599	,,
No. 3	Do.	...	...	...	...	...	...	587	,,
No. 4	Do.	...	...	...	...	...	...	897·1	,,

As a group of boilers without any coal alongside it is of no use for driving the ship, the problem was to so work the boilers on a passage as to leave coal enough alongside each group to allow of steaming at full speed if required. When possible one day's steaming was left alongside each group.

Working on this basis, the table below gives the amount of coal left in each boiler room, the quantities available for making the passage, and the number of days steaming thus allowed for each room:—

	Tons of Coal for One Day's Steaming.	Tons of Coal Available for Passage.	Number of Days Steaming.
No. 1	81 5	452	5·54
No. 2	112	487	4·35
No. 3	126	461·5	3·66
No. 4	126	771·1	6·12

The greatest quantity of coal was in No. 4 room, which as a consequence was worked most. The next room is No. 1.

From the table it will be seen that except No. 4 room, 4 days was about the limit a room could be steamed, and for this period clinkering was found quite sufficient to meet all requirements.

hour at 1·5. 1·6. 1·7. etc., etc., lbs. per I.H.P. per hour. But the coal is required at given revolutions such as, say, 95. Through V draw the horizontal line D V, cutting the revolution curve at D, through D the vertical line D E, cutting the power curve at E, and through E the horizontal line E F, cutting Q R at F. Through O and F draw O F G I. Then the intersections of the vertical lines through 1·5. 1·6. 1·7. 1·8 . . . and 2·5 with O F G I are equal (to scale) to the skids per hour for 95 revolutions at 1·5. 1·6. 1·7. 1·8. . . . and 2·5 lbs. per I.H.P. per hour.

APPENDIX II.

CONSTRUCTION OF SLIDE RULE. (See Fig. 7, Plate XXV.)

Scale = log. of numbers × 20 in inches.

Thus coal at 40 revolutions for main engines at 2 lbs per I.H.P. per hour = 13 skids: total coal + auxiliary = 21 skids.

Log. 21 = 1·3222193, scale = 26·444386″.

Coal at 120 revolutions for main engines = 213 skids.

Total coal at 120 revolutions = 221 skids.

Log. 221 = 2·3443922, scale = 46·807846″.

Slide—

Log. 8 = ·9030900 scale = 18·0618″

Log. 43 = 1·63345 „ = 32·669″

Firing table—

Log. 1·1 = ·004139 „ = ·827″

Log. 7 = ·845098 „ = 16·901″

Scale for clinkering fires—

Log. 4 = ·6020600 „ = 12·0412″

Log. 38 = 1·57975 „ = 31·595″

Position of scales—

At 40 revolutions total coal = 21 skids.

Skids per boiler per hour using 8 boilers $= \frac{21}{8} =$ log.

21 — log. 8.

1·3222193

·9030900

·3191293 = 2·085 skids per hour.

Distance of 2·085 from the top of right h | 3191; |

× 20 inches = 6·382586″; but 1·1 skids = ·

Distribution of Stokehold Hands on Watch.

The distribution of work among the stokehold watch keepers is to be as follows:—2 stokers firing 4 boilers, 1 firing 1 and 2, the other 3 and 4; 2 stokers getting out coal, one of whom is to assist men at fires when slicing, clinkering, and sending up ashes. The stokehold plates are to be kept swept up.

* When steaming at ordinary rates, *i.e.*, consuming about 18 lbs. of coal per square foot of grate per hour, each fire is to be thoroughly clinkered once every 8 hours, the odd numbers in one watch, and the even numbers in the next.

While clinkering is in progress, the stokers attending to the firing of the other two boilers will fire all the furnaces in their proper order, except the one which is being clinkered, the stoker attending to the boiler in which the fire is being clinkered doing the clinkering, assisted by one of the two stokers told off for getting out coal.

Instructions for Clinkering Fires.

The number of fires to be clinkered during each four-hour watch is to be determined by the following formula:—

$$N = \frac{YX}{30}$$

where N = number of boilers to be clinkered each watch.
X = number of boilers in use.
Y = rate of combustion in lbs. per square foot of grate per hour.

When N includes a fraction, the fraction is to be neglected when less than ·5, and when ·5 or more the next highest number is to be taken.

This formula is based on the assumption that when burning coal at the rate of 15 lbs. per square foot of grate per hour the fires should be clinkered every 8 hours. Should the coal form clinker at a greater rate than usual the number N given by the formula would be increased. The number of fires clinkered in a watch is to be spread equally over the whole watch as far as possible, to ensure as uniform a rate of combustion as possible.

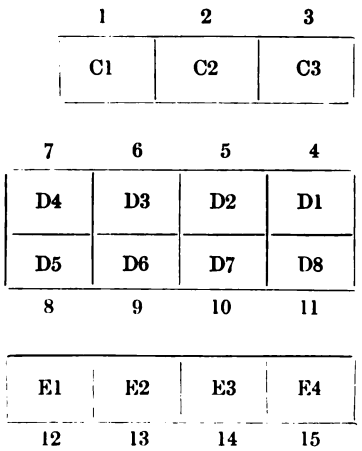
A slate will be kept in the engine room, which is to be made out at the commencement of each watch for the information of the chief stoker of the watch, showing the distri
and numbers of the boilers to be clinkered each

* Cancelled by later i

When the number of fires to be clinkered each watch has been determined, proceed to number the boilers, commencing from forward (*vide* sketch).

The first watch will commence clinkering all the odd numbered boilers, and then the even numbered (should the odd numbers not prove sufficient) until $X \frac{Y}{30}$ boilers have been clinkered. The next watch will carry on where the former left off, and complete the number of boilers with odd numbers and so on.

Illustrations.—Steaming with C, D and E at 18 lbs. per square foot of grate $N = \frac{15 \times 18}{30} = 9$.



Watches.	1st Hour.	2nd Hour.	3rd Hour.	4th Hour.
1st Watch	Nos. 1 and 3 C1 and C3	Nos. 5, 7 and 9 D2, D4, and D6	Nos. 11 and 13 D8 and E2	Nos. 15 and 2 E4 and C2
2nd Watch	Nos. 4 and 6 D1 and D3	Nos. 8, 10 and 12 D5, D7, and E1	Nos. 14 and 1 E3 and C1	Nos. 3 and 5 C3 and D2
3rd Watch	Nos. 7 and 9 D4 and D6	Nos. 11, 13 and 15 D8, E2 and E4	Nos. 2 and 4 C2 and D1	Nos. 6 and 8 D3 and D5
1st Watch	Nos. 10 and 12 D7 and E1	Nos. 14, 1 and 3 E3, C1 and C3	Nos. 5 and 7 D2 and D4	Nos. 9 and 11 D6 and D8

The PRESIDENT said—I am sure we are all much obliged to Mr. Baker for giving us this paper. It conveys to me an idea of magnitude and complexity, and of the enormous number of operations, in a way which no other paper I have read in regard to steamships has ever done.

The discussion was adjourned until next meeting.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

TWENTIETH SESSION, 1903-1904.

PROCEEDINGS.

CLOSING BUSINESS MEETING OF THE SESSION, HELD IN THE LECTURE HALL OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON WEDNESDAY, MAY 18TH, 1904.

PROFESSOR R. L. WEIGHTON, M.A., VICE-PRESIDENT, IN THE CHAIR.

The CHAIRMAN said—I regret having to intimate that we have a telegram from Mr. Tweedy saying that he is very sorry to say he cannot be present to-night. That is why I appear in the chair. There is also a telegram addressed to the President from Mr. Fothergill, in which he says that he is very sorry he is unable to attend the meeting to-night. He sends his best congratulations to the President on completion of his two years' tenure of office.

The SECRETARY read the minutes of the previous meeting held in Newcastle-upon-Tyne on Friday evening, April 22nd, which were confirmed by the members present and signed by the Chairman.

The CHAIRMAN appointed Mr. C. A. Bushell and Mr. R. H. Muir to examine the voting papers, and the following gentlemen were declared elected:—

MEMBERS.

Brown, Joseph, Engineer, 26, Fern Avenue, Jesmond, Newcastle-upon-Tyne.
Furness, Stephen Wilson, Shipbuilder, Messrs. Furness, Withy & Co., West Hartlepool.
Lamberti, James, Engineer, 271, Albert road, Jarrow-on-Tyne.

RESUMED DISCUSSION ON ENGINEER-LIEUT. E. F. BAKER'S PAPER ON "THE MANAGEMENT OF BELLEVILLE BOILERS AT SEA."

Mr. JAMES STEWART said—I did not come prepared to make any remarks on Engineer-Lieut. Baker's paper, but I am pleased to have the opportunity of expressing my sense of its value, a value which will be readily admitted, seeing that it shows how these boilers can be managed with success on regular service. And what strikes one most after reading the paper is the great amount of diligence and perseverance that must have been exercised in originating this system of doing the work of the stokehold and in carrying it out apparently to a successful issue. It shews also that an elaborate system of this kind is really essential to the satisfactory and economical working of the Belleville boilers at sea; and this fact seems to me to provide an argument against their adoption in the mercantile marine. In the Royal Navy, where there are all the advantages of perfect discipline and a regularly trained staff, it is quite possible to carry out such a system, but in merchant steamers the frequent changes in the staff and the general conditions seem to render it quite impracticable.

The CHAIRMAN (Prof. R. L. Weighton) said—This is hardly a paper that lends itself readily to discussion. I shall ask Engineer-Lieut. Baker to add anything further he may have to say; and I would like to ask him if the elaborateness of this system of firing at sea with water-tube boilers is not due to the fact that such an abnormal amount of power has to be taken out of them in proportion to their heating surface, weight and space occupied. We all know that war vessels have to be capable of developing powers much beyond the normal, and whilst I fancy that the necessity for the system described may be largely due to the excessive forcing of the boilers, I would like to know whether, to obtain the normal powers on boiler weight, suitable for merchant ship practice, such an elaborate system of firing would, in Engineer-Lieut. Baker's opinion, be required.

ENGINEER-LIEUT. E. F. BAKER'S REPLY.

Engineer-Lieut. BAKER said—I have prepared a few notes, as I rather expected to be taken to task on the question of the utility of an elaborate system of firing.

What led to the introduction of the system in H.M.S. "Good Hope" was, that it was found that something had to be done to deal with the frequent and often considerable variations in the rate of combustion, and to ensure uniformity in the working of the boilers, as well as to control the consumption of coal in the different bunkers.

With reference to the remarks of Professor Weighton, I certainly think any form of water-tube boiler could be made to work satisfactorily in the merchant service without an elaborate system of firing, as there the boilers would be worked at an uniform rate of combustion, and as much would be got out of them as possible under natural draught conditions. I quite agree with Mr. Stewart that such a system as described would be undesirable in the merchant service, but, as I have just said, I do not think it would be required there.

I do not know what the usual consumption per square foot of grate is nowadays in the merchant service, but with a steady rate of steaming the men would easily fall into the way of regularly firing, when there would be no necessity for any bell ringing. The same thing was experienced in the "Good Hope," where a watch, after being below for half an hour or so when cruising at an uniform speed, would pick up the time interval of firing, and go from fire to fire almost without having to attend to the bell at all. Unfortunately, in a man of war, when manœuvring with a squadron, the conditions are so different that a control of the firing is necessary.

I was sorry to notice the other day that my paper was being made use of as a strong argument against the Belleville boiler by one engaged in singing the praises of another (I am ready to admit, excellent) water-tube boiler, as it shows a want of appreciation of the requirements of a boiler for naval purposes. I do not question the results of the trial referred to, but I am not at all certain that they are so very much superior to those obtained in the "Sharpshooter" when the Belleville boiler was first introduced. What I wish to point out is that it is not such

a simple matter to predict the results of a large instalment from those obtained from a small one, also that to set a ship the task of steaming so many miles at an uniform speed is not a fair test, as it does not represent all the boiler will be called upon to do when on active service.

When you set a ship such a task, a sufficient number of boilers would be lit up to give the speed at a certain rate of combustion per square foot of grate, and the results so obtained would be a measure of the economy of fuel at that particular rate; but it does not by any means follow that the economy will be the same for all other rates, whether higher or lower, or when frequently changing. As for carrying out a set task, I do not think much fault can be found with the performances of the "Spartiate" on the run home from China.

The question is, Will the boiler (referred to) do as well as the Belleville in a large instalment with a varying rate of combustion and without such a system of firing? If not, and should such a system be found necessary to get the same economy, I fail to see that it has any advantage over the Belleville from the point of economy.

As I said just now, one of the reasons for introducing time-firing in the "Good Hope" was the frequent variation in speed required for the duty on which the ship was employed. The first squadron the ship joined was rather a scratch one at the time, where practically no cruiser work was done, as all the ships at steam tactics manœuvred in the line. The outcome was that sufficient boilers were lit up for the speed ordered at from 14 to 15 lbs. per square foot of grate, when everything that was asked for could be done without any heart-breaking.

The next fleet the ship joined was one that had been a standing fleet for some time, where as a consequence steam tactics had been brought to a fine art. The orders of this fleet were that the battleships were to have two knots in hand above the speed of the flagship, and the cruisers two knots above the battleships, or four knots above the flagship's speed. The tactics were generally done at, or a little below, the speed of the flagship, at which speed the coal consumption of the cruisers was at times considerably in excess of what it should have been at that speed. While attached to this squadron we were in company with a sister ship, two ships of the "Cressy" class

To illustrate Mr. H. M. Wilson's Paper on "Automatic Governing of Marine Engines."

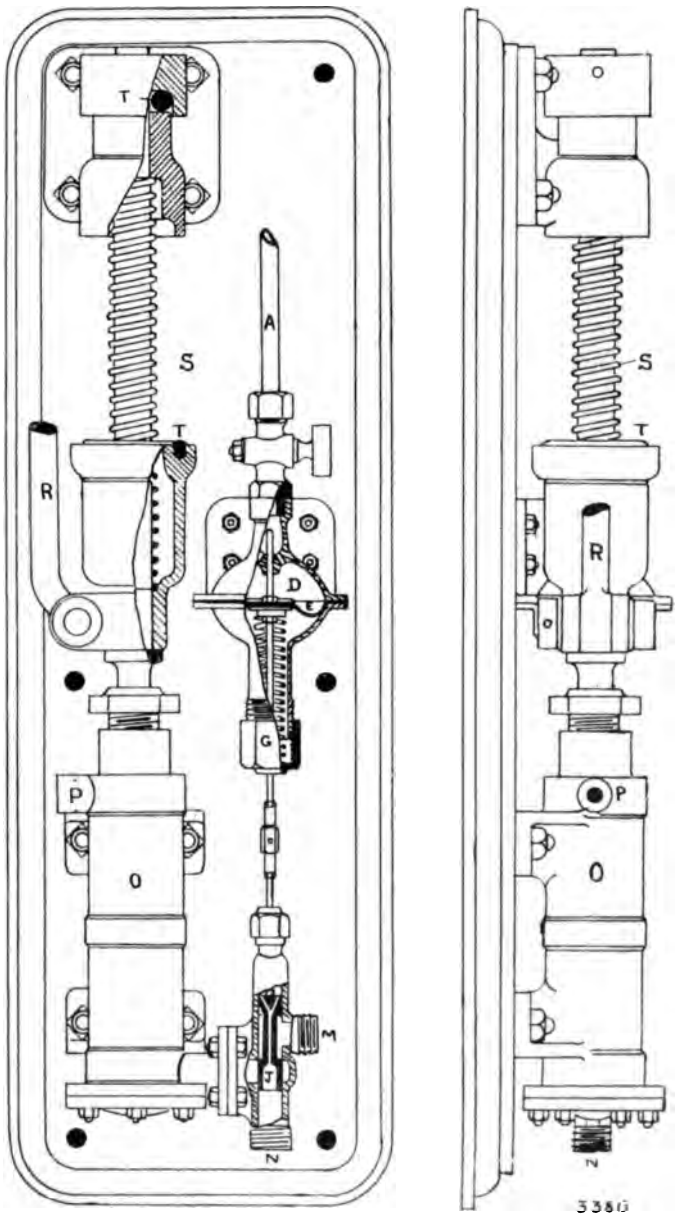


FIG. 5.—COUTS' & ADAMSON'S GOVERNOR.

the watch is held responsible for all that goes on below during his watch. Under the circumstances the more he can personally direct, the more he has at his finger ends the less the anxiety of things going wrong. Without a system of firing, the steam-keeping must, in a large measure, be left in the hands of sub-ordinates on whom the officer of the watch has, as a consequence, to depend. One of these subordinates may be a hopeless fool, who would let the officer of the watch in by his folly, and even were they all the best that could be found, how are they in the stokeholds, many feet away from the engine-rooms, to know what the speed is? And even if they were acquainted with the changes in speed as they took place, how are they, even approximately, to estimate the effect of the changes on the rate of combustion? Again, you would not find two leading stokers with the same estimate of the consumption to suit the speed, with the result that you would have no means of even approxi-mately estimating the time the coal round a certain group of boilers would last, or controlling the consumption of coal in the different bunkers.

As far as means of communication are concerned, there are of course voice pipes, but those who have had anything to do with men of war know what a lot of use they would be for transmitting orders at frequent intervals.

Another thing, leaving the steam-keeping to the petty officers and stokers puts on the shoulders of these men a burden they have no business to carry. They are there to do certain physical work, and not to be tired out with additional worry. Those who have had to deal with men know what an excellent thing worry is for exhausting energy, and I think if one only set about it the right way one could take more out of a man by worry in two hours than one could in four with physical labour alone. I consider the care of the men under him as much the duty of the officer as the care of the machinery, and just as he is expected to keep the machinery in an efficient state, and ready for the maximum output at the shortest notice, so he should deal with his men with the same object in view. This is one of the differences between the naval engineer and an engine driver. An engine driver you can get at a fairly reasonable price, and if it were only engine driving that was required of the naval engineer you are paying very much more for what you want than you should.

To illustrate Mr. H. M Wilson's Paper on "Automatic Governing of Marine Engines."

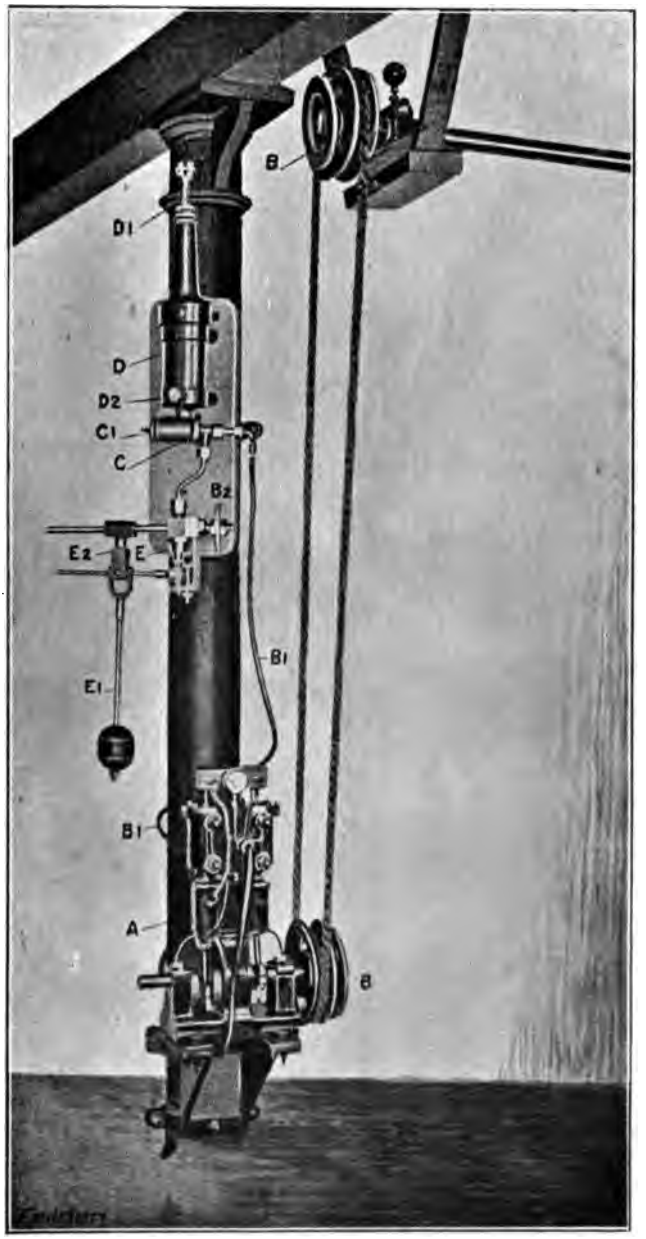


FIG. 6.—THUNDERBOLT'S GOVERNOR.

CLOSING BUSINESS.

ALTERATION OF BYE-LAW 12.

The CHAIRMAN, on behalf of the Council, moved that the following alterations be made in Bye-law 12 (the alteration is printed in italics):—

> "12.—The result of the ballot for Officers shall be declared at the Closing Business Meeting, to be held in May, at which meeting general business shall be transacted. *The newly-elected Officers shall enter into office on the 1st day of August following; and the new President shall be installed at the Annual General Meeting in October.*"

He said—Perhaps I may say that the reason for this alteration is as follows. It has been felt for many years back that Bye-law 12 operated rather awkwardly, for this reason, that the new President being installed into office at the last meeting of the session, the very first business he was called upon to transact was to close the session—not at all an inspiriting function for anyone starting an office of any sort. It was considered that it would be much fitter if, instead of assuming the reins of office at the closing meeting of the session, he should do so at the opening meeting of the following session, when his presidential address would de delivered. If the old rule, for instance, had been followed to-night, the new President would have been present to close the session. Whereas, the new President, if this rule is carried, will not appear till the opening meeting of next session. He will be installed then and his presidential address will immediately follow as a matter of course. The reason why the new officers will take office on the 1st of August is to secure that their nominal assumption of office will coincide with the financial year of the Institution. The new President also will of course nominally take office on that date, but will not enter into the actual, visible discharge of his duties until the day on which the session opens. I therefore propose, in the name of the Council, that this rule be altered.

The motion was agreed to unanimously.

ELECTION OF AUDITORS.

Mr. R. H. MUIR said—I have pleasure in proposing that Messrs. R. W. and J. A. Sission be re-appointed auditors of this Institution.

Mr. C. A. BUSHELL: I have great pleasure in seconding that.

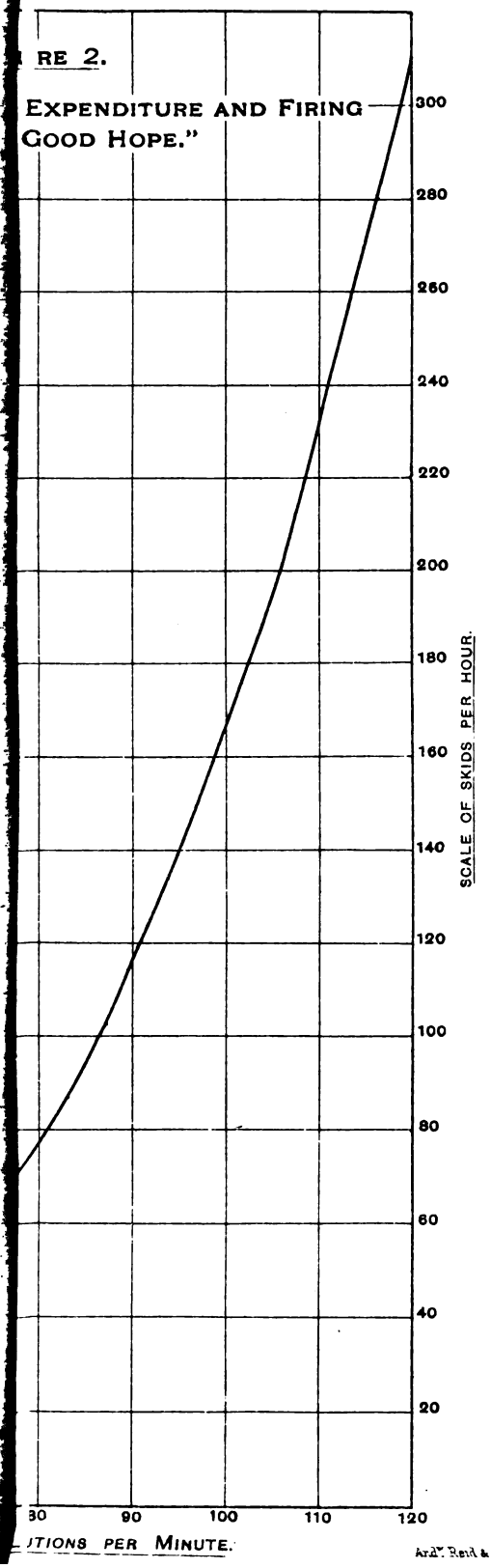
The motion was agreed to.

The CHAIRMAN—I have to declare that the following gentlemen have been elected to fill the vacancies in the Council list:—

President—Right Hon. Lord Armstrong.
Vice-Presidents—Messrs. J. H. Heck, D. B. Morison, and T. Westgarth.
Hon. Treasurer—Mr. G. E. Macarthy.
Ordinary Members of Council—Messrs. M. C. James, Hugh Laing, Hon. C. A. Parsons, R. Ropner, junr., and W. Swinney.

VOTE OF THANKS TO THE RETIRING PRESIDENT.

The CHAIRMAN said—The next business is a vote of thanks to the retiring President, and I think I may claim the privilege of proposing it. It so happens that I am very intimately acquainted with the work which the retiring President has done during the past two sessions. Speaking from my own personal knowledge, I have to assure you that Mr. Tweedy has not spared himself during his tenure of office. He has been most indefatigible in his devotion to the work of his office. These are no empty phrases that I am using; they represent actual fact. He has not only attended all the meetings of the Council, but he has studied beforehand each question which was coming up, and very fully considered all the pros and cons of it. That, as you may suppose, means a considerable amount of time and energy devoted out of the life of a very busy man of business to the work of the Institution. There is one matter in which I think Mr. Tweedy has specially signalised his tenure of office, and that is in the very great amount of service he has rendered, not only to this Institution, but to the profession and business of engineering and shipbuilding generally, and to the whole country, by his devotion to the matter of the future education



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MEMOIRS.

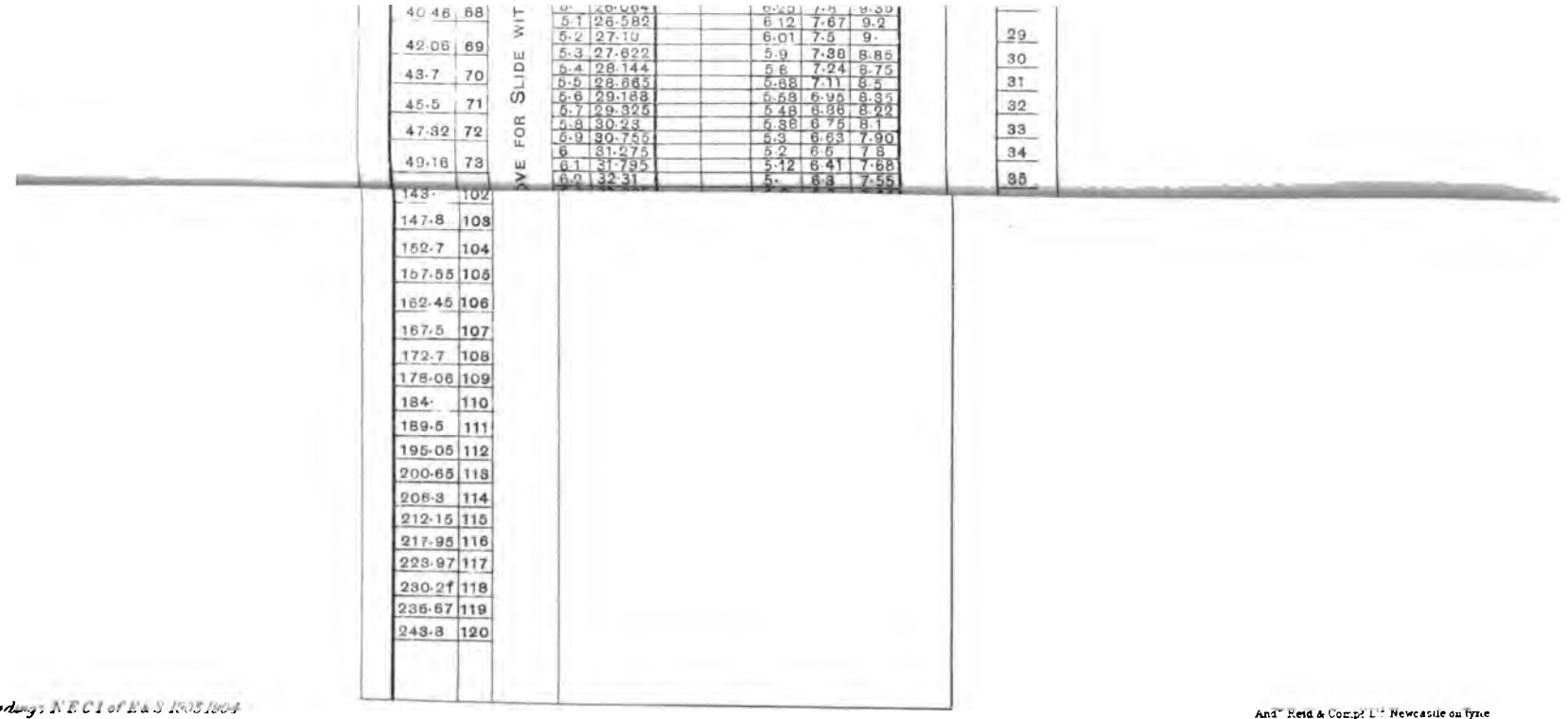
MR. JOHN BULMER.

Mr. John Bulmer was born at Newburn, a small village the banks of the river Tyne about six miles west of Newcastle, the 7th of April, 1834. At the age of eight years he was t to work at one of the local collieries and afterwards he ved his time and worked as a journeyman in several of the gineering works of the district.

In 1873 he commenced business with the late Mr. Wardugh, the firm being known as Wardhaugh and Bulmer, and 1880 he took over the old Spring Gardens Engineering Works ich had been in existence since the year 1805. Mr. Bulmer s in the truest sense a thorough practical engineer and his entive genius had already shown itself in the many improvents he had introduced into the special machines he made; t when he took over these works he there founded perhaps e of the most unique concerns in the country. He made a ciality of the manufacture of machines for wire and hemp e making and cordage, also for the making of electrical wires, d cables. By his inventive genius and excellent workmanip he gained a world wide reputation and his name became mous as the pioneer of rope machine makers. For some years st his four sons became associated with him and the business s still carried on by them.

Mr. Bulmer took no prominent part in political or municipal affairs. He preferred to devote his life in the interests of engineering, and in this he was most successful. He was of a kind and generous disposition and won the respect and esteem of all who came in contact with him, either in business or private life.

He joined this Institution in 1886; he was one of the oldest members of the Newcastle and District Association of Foremen Engineers and Draughtsmen, an association in which he took a keen interest. He was also a member of the Institution of Mechanical Engineers. He died on the 31st of October, 1903, after one day's illness.



Proceedings N.E.C.I. of E. & S. 1903-1904
Session XX

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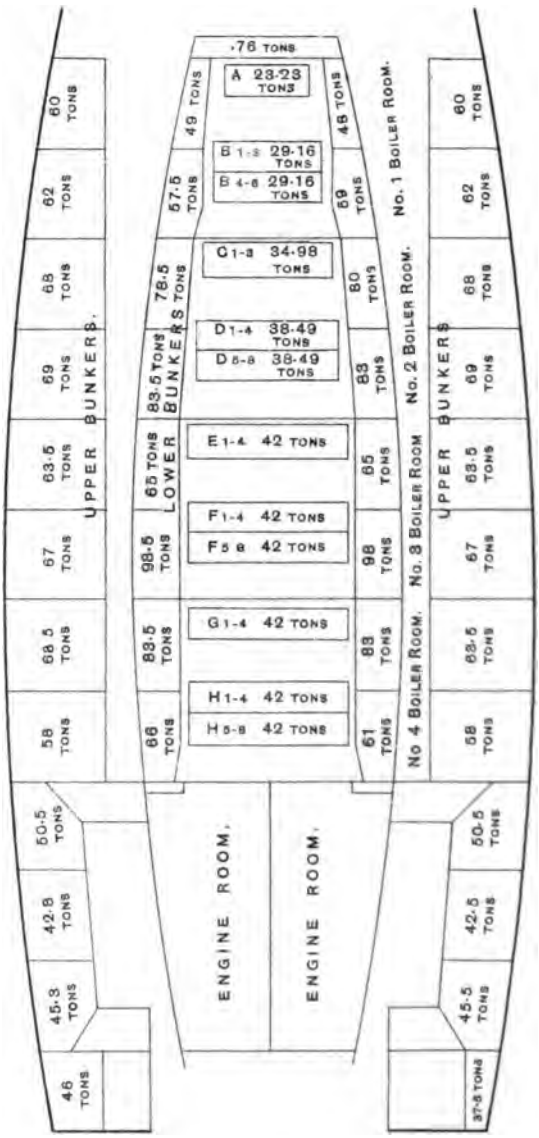
Illustrate Eng. Lieut E.F. Baker's R.N. Paper on "Management of Belleville Boilers at Sea."

Figure 5.

Plan of Upper and Lower Bunkers with Capacity in Tons.



The Figures on the Groups of Boilers are the Consumption in Tons per day at a rate of Combustion equal to 18 lbs. per ☐ft of Grate.

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his readiness at all times to assist others gained for him the esteem and goodwill of all with whom he came in contact.

He was a member of the Institution of Naval Architects, London; and a vice-president of this Institution which he joined at its formation in 1884, and in the business of which he always took a lively interest.

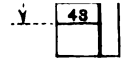
For some time prior to his death he suffered from a distressing malady, and in April, 1903, he underwent a severe operation which was successfully performed, and was again able to resume his professional duties. But in the following October he was again incapacitated and obliged to give up active life. He died on the 14th day of December, 1903. Being of a warm and genial temperament he had many friends who now deplore his loss.

MR. JOSEPH LOWES THOMPSON.

Mr. Joseph L. Thompson was the grandson of Robert Thompson, the founder of the firm of Joseph L. Thompson & Sons, Ltd., North Sands Shipbuilding Yard, Sunderland, and was the second son of the late Joseph L. Thompson. He was born at Monkwearmouth, on January 27th, 1853, and died at his Sunderland residence on the 28th November, 1903. After being educated at Gainford he served his apprenticeship partly with his father, at the North Sands shipyard, and partly with his uncle at Southwick. He joined his father's firm in 1870 and became a partner in 1875, and continued to be actively engaged in, and did much to develop, the business until 1893, when he was compelled to retire from active work, through failing health, although he continued until his death to take an interest in the business and retained his position as a director.

He had a short but useful public career, as chairman of the now defunct Monkwearmouth Burial Board, the methods of management of which he greatly improved, and as a member of the Borough Council from 1888 until 1897, when, owing to the state of his health, he retired. He was a magistrate for the county and sat regularly on the bench of the Barnard Castle division.

Perhaps, however, his interests, outside of his business, were mainly centered in religious and philanthropic work, in which



NOTE.—The Figures on right-hand side of Rule are the same as in corresponding space on Rule, Figure 4.

And. Reid & Comp^y L^td Newcastle on Tyne